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THE

PALÆONTOGRAPHICAL SOCIETY.

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LONDON:

MDCCCLXXXVIII—MDCCCXCIX.

MONOGRAPH OF THE BRITISH PALÆOZOIC PHYLLOPODA.

DIRECTIONS TO THE BINDER.

The Monograph of the British Palæozoic Phyllopoda will be found in the Volumes of the Palæontographical Society for the years 1887, 1892, 1898, and 1899.

Cancel the Title-pages of Parts I, II, III, and IV in the Volumes for the years 1887, 1892, 1898, and 1899, and *substitute* the General Title-page given in the Volume for the year 1899. *Cancel* page of Addenda et Corrigenda in Part II, and pages 175 and 176 in Part III, and *substitute* pages 175 and 176 (reprinted) in Part IV.

ORDER OF BINDING AND DATES OF PUBLICATION.

PAGES	PLATES	ISSUED IN VOL. FOR YEAR	PUBLISHED
Directions for Binder	—	1899	December, 1899.
General Title-page	—	—	,, ,,
Contents, i	—	—	,, ,,
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73—124	XIII—XVII	1892	November, 1892.
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A MONOGRAPH

OF THE

BRITISH PALÆOZOIC PHYLLOPODA

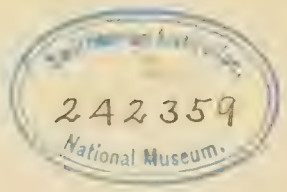
(PHYLLOCARIDA, Packard).

BY

PROF. T. RUPERT JONES, F.R.S., F.G.S., &c.,

AND

DR. HENRY WOODWARD, F.R.S., F.G.S., &c.



LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1888—1899.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20. HANOVER SQUARE, W.

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5 and 6.	*Caryocaris Wrightii*, Salter, from Huy, Belgium	91
7.	*Aptychopsis prima*, Barrande, from Bohemia	100
8, 9, and 10.	*Aptychopsis Salteri*, Woodward, *A. ovata*, J. and W., and *A. prima*, Barrande; outlines compared	109

WOODCUTS IN PART III (1898).

	Not numbered sections of quarry at Congleton Edge	154 and 155

WOODCUTS IN PART IV (1899).

	Not numbered section of quarry at Congleton	xiv
11, 12 A, 12 B, and 13.	*Lebescontia ænigmatica*, J. and W., from Brittany	199
14, 15, 16 A, 16 B.	*Lebescontia occulta*, J. and W., from Scotland	203

ADDENDA ET CORRIGENDA.

Part I.

Page 11. After the 16th line from the top *add* 1885, J. M. Clarke. The Higher Devonian Fauna of Ontario County, New York, pp. 43, 44.

Pages 16 and 19. Pl. IV, fig. 3, is *Ceratiocaris tyrannus* (not *C. Murchisoni*).

Pages 20 and 21. Pl. VI, fig. 11, is *Ceratiocaris tyrannus* (not *C. valida*).

Page 23. Before the 10th line from the bottom *add*:—A specimen of *C. tyrannus* from the Upper Coldwell beds, near Troutbeck, Westmoreland, is in Professor Törnquist's collection, Lund.

Page 25. In the last two paragraphs lines 2nd and 5th from the bottom may refer to *Ceratiocaris tyrannus* rather than to *C. gigas* or *C. Murchisoni*.

Page 37. Add to the foot-note—and 'Mem. Geol. Surv.,' Explan. Sheet 23 (1879), pp. 9, &c.

Page 44. The 4th paragraph from the bottom refers to *Ceratiocaris patula* (not to *C. robusta*).

Page 45. In the paragraph of lines 10 to 6 from the bottom, *for* telson *read* style.

Pages 61 and 72. Plate XI, fig. 16, may belong to the genus *Elymocaris*, Beecher, as suggested at p. 62.

Pages 62 and 72. *Ceratiocaris? lata* belongs most probably to *Hymenocaris*.

We have to add that in the Lee Collection, British Museum, there are—

I, 1163. From the Upper Ludlow beds of Logan Water, portions of the tail-pieces of *Ceratiocaris papilio*.

I, 1169. From the Lower Ludlow of Leintwardine, near Ludlow, the end of an abdomen, telson, and cercopods of *C. papilio*.

I, 1167. From the Lower Ludlow of Church Hill, Leintwardine, the inside exposure of a left-hand valve of *C. Halliana*.

I, 1170. From the same locality a nearly perfect specimen of *C. Halliana*, young.

I, 1168. From the Lower Ludlow beds, Ludlow—*C. cassia*

Part II.

Page 95, heading, *for* Caryocaris Salteri *read* Sutural Carapaces and others.
,, 97, line 16 from the bottom, *add* and vol. vi, pl. clxxxiii, figs. 1, 2.
,, 98 ,, 3 ,, *for* Regiones D et E *read* Regis D E.
,, 101 ,, 2 from the top, *for* Butowitz *read* Bubowitz.
,, 101 ,, 7 from the bottom, *after* vertical *insert* (dorsal).
,, 103 ,, 13 from the top, *for* cordiformis, sp. nov., *read* anatina (Salter, 1873).
,, 103 ,, 29 ,, *for anatina* is probably *read Marrii* is.
,, 103 ,, 7 from the bottom, *delete* Coll. Marr.
,, 107 ,, 13 from the top, *for* Inverleithen *read* Innerleithen.
,, ,, ,, 24 ,, *insert* Clingani-shales *after* No. 9.
,, 110 ,, 13 ,, *for* Lower *read* Upper.
,, ,, ,, 15 ,, *for* 1860 *read* 1862.
,, ,, ,, 2 from the bottom, *for* Lower *read* Upper.
,, 113 ,, 9 ,, *insert* — — *Nicholson*, 1879. Palæontology, edit. 2, p. 348, fig. 203 *d*.
,, ,, ,, 21 ,, *delete* and 9.
,, 114 ,, 12 ,, *for* anatina, Salter, 1873, *read* Marrii, sp. nov.
,, 115, heading, *for* anatina *read* Marrii.
,, ,, line 4 from the top, *insert* by us *after* thought.
,, ,, ,, 7 ,, *for* mudstone of the Coniston series *read* band of the Skelgill shales.
,, 116 ,, 16 ,, *after* from *insert* the Skelgill beds of.
,, 121 ,, 13 ,, *for* A. Z. *read* the Argenteus-zone of the Middle Skelgill Beds.
,, 123 ,, 2 ,, *for* Coniston mudstone *read* the Argenteus-zone of the Middle Skelgill Beds.
,, ,, ,, 23 ,, *for* A. Z. *read* the Argenteus-zone of the Middle Skelgill Beds.
,, 124 ,, 14 ,, *for* graptolitic shale *read* mudstone of the "barren band" of the Lower Skelgill Beds.
,, ,, ,, 2 from the bottom, *for* 8, 9, and 10, *read* 9, 10, and 11.

Part III.

Page 125, line 5 from bottom, *for* Robroystone *read* Robroyston.
,, ,, ,, 3 ,, *for* Limestone *read* Ironstone.
,, 126, ,, 9 from top, *after* limestone *insert* , Carluke.
,, ,, lines 17 and 16 from bottom, *read* strata under the Main Limestone series at Craigenglen, Campsie.
,, ,, line 5 from bottom, for *D. insignis add also* Kilbride as a locality.
,, 127, first line, for *Chænocaris* read *Calyptocaris*.
,, ,, line 9 from top, *after* shales *add* over the Calderwood Cement-limestone, East Kilbride.
,, ,, ,, 16 ,, *after* Ireland. *add* The Cock of Arran.

"The Cock of Arran" is a large fragment of fallen rock lying on the "Raised Beach," and is so named because it was at one time supposed to resemble that bird. It gives its name to the local

farm, and is shown on the maps and mentioned in the guide-books. It is referred to in the 'Trans. Geol. Soc. of Glasgow,' vol. x, pp. 293, 296.

The tooth alluded to at p. 197, and shown in Pl. XXVI, figs. 33 and 34, was got from one of the red limestones on the beach. These belong to the Upper Limestone.—J. Neilson, in Letters.

Page 127, line 17 from top, *for* is *read* was.

„ „ lines 18 and 19, *read* Calderside, Kirktonholme, and Glebe quarries, and elsewhere in the parish of East Kilbride. Consult 'Memoirs Geol. Survey Scotland,' Explanation of Sheet 33, pp. 28—30; and Patton, "Geology of East Kilbride," 'Trans. Geol. Soc. Glasgow,' vol. vii, p. 309.—J. Neilson, in Letters.

„ „ line 19 from top, *for* two feet *read* eleven inches.

„ 128, „ 3 „ *for* Ironstone *read* Ironstones; and *after* Rutherglen *add* Lanarkshire Coal-field.

„ 132, in the table, *bracket* 12 and 13 *together, and* 14 and 15 (*not* 12—14).

„ 133, line 17 from top, *read* Nos. 12 and 13.

„ „ „ 18 „ „ Nos. 14 and 15.

„ „ „ 19 „ *for* is *read* are.

„ „ „ 3 from bottom, for *Ch.* read *Calyptocaris.*

„ 135, last line of the table, for *Chænocaris* read *Calyptocaris. The bracket should not include* No. 27.

„ 139, line 2 from top, *after* fluted *add* , showing the ventral aspect.

„ „ „ 13 „ *add* Aspect doubtful.

„ 140 „ 6 „ *add* The granulation of the dorsal surface extends over the ridge also.

„ „ „ 16 „ *add* Probably ventral aspect.

„ „ „ 9 from bottom, *insert* Additional specimens of *Dithyrocaris glabra*, Brit. Mus., Nos. 2, 3, 4, 5, 7, all from East Kilbride.

No. 2 in non-calcareous black shale. No. 3, two separate left valves. These have no fringe on the ventral border, but the edge is turned up as a sharp rim along its front half. In very slightly calcareous black shale. Nos. 4 and 5 in black shale slightly calcareous. No. 5 is a left valve, together with the filmy relic of another similar valve, with a narrow fringe and very fine mesolateral (?) ridge. No. 7 a right valve, badly preserved as a light brown film. No. 8 (Pl. XXV, fig. 2) has a delicate fringe, continued forward into the simple raised ridge. Mus. Geol. Surv. Scotl., No. 25, is from "the shore east of Ardross Castle, Elie." In the British Museum there is a group of fifteen loose pieces of black shale with fragments of *D. glabra*, of which seven are from Ardross and eight from Castle Ardross.

"There are two places at Ardross where fossils are found. One is a little west of the remains of the old castle, and the other about a hundred yards east of it. The latter place is where *Dithyrocaris* and other crustaceans are met with. 'Ardross' and 'Ardross Castle' are used indifferently for either or both spots. Ardross itself is a farmhouse, and nearest to the *Dithyrocaris* locality. There is no village called Ardross. Elie is about a mile to the west, and is the nearest post-town and railway-station."—J. W. Kirkby, July 5th, 1898.

Page 144, line 5 from bottom, *add* At its broken end in front the ridge overrides the edge of the right valve, and its left side has been pressed at a steep angle to the other valve.

„ 145 „ 12 from top, *add* Another *D. granulata* is Brit. Mus., No. 13, from East Kilbride. It has a rugose mesolateral ridge.

„ „ „ 14 „ *add* 10 *after* 6.

„ 146 „ 13 „ *add* The style is bayonet-shaped, with a midrib more or less recog-

nisable on each face. The stylets are sulcate, their riblets or costulæ between the furrows varying in number up to six.

Page 147, line 12 from top, *insert* The style has only a midrib; the stylets have three or four costulæ. At the end of the third paragraph *add*; and this accords with the disturbed (probably twisted) state of the abdominal segments outside the carapace.

„ 148, „ 6 „ *for* XXIX *read* XXXI.

„ 150, „ 4 „ *after* fig. 4 *insert a, b, c, d.*

„ „ „ 7 „ *delete the words between* shows *and* part.

„ „ „ 9 „ *delete* impress of the.

„ „ „ 11 „ *add* For a more correct description of the magnified figure see below.

„ „ „ 13 „ *delete the words between* shows *and* that.

„ „ „ 19 „ *add* Pl. XXXI, figs. 4 *a, b, c, d*, being magnified figures of this specimen, allow of a more correct description, thus:

Size.—Stylets possibly about 35 mm. long when perfect.

Characters.—This specimen, magnified two diameters, shows the ventral aspect of a part of the last abdominal segment and of the trifid appendage. Parts of the dorsal face of each stylet are shown in intaglio by the loss of the ventral moiety. A part of the head of the left-hand stylet has been broken away, leaving an impression of its dorsal surface, shown by fig. 4 *b*. This figure (magnified ten diameters) also shows the subsidiary oblique striæ on the riblets of both faces, which are four on the ventral and six on the dorsal face.

The minute lateral striæ trend upwards, *i. e.* backwards, on both faces, but are more delicate and numerous on the riblets of the dorsal face. Marginal pittings, which were the bases of hairs, setæ, or spinules, are magnified in fig. 4 *c*, from the right-hand stylet.

The ornament of chevron-like lines, with short, oblique, intermediate cross-lines is seen on a magnified (30 diameters) part of the ultimate segments in fig. 4 *d*.

The style is straight, coarsely fluted above and bayonet-shaped below; the stylets are slightly curved; coarsely striate on the dorsal, and sulcate on the ventral face.

Page 151, line 22 from top, *for* fig. 1 *read* fig. 1 *a*.

„ „ „ 2 from bottom, *add* It retains part of the ventral fringe. There is the mark of a gastric tooth in its place; and there are two separate teeth, obscured with a shaly coating, in the slab.

„ „ last line, *for* Black calcareous shale *read* From the Cement-stone.

„ 152, line 22 from top, *add* In hard dark-coloured calcareous shale.

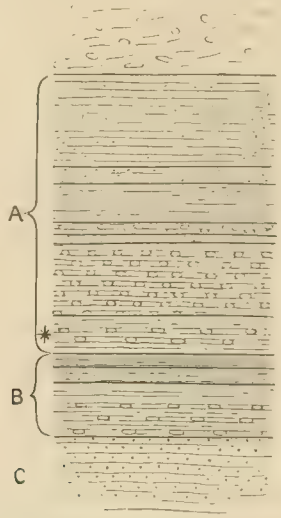
„ 153, first line, *after* 10 *a, b, add c*; *for* 11 *read* 11 *a, b*; *for* 12 *a, b, read* 12 *a—d.*

„ „ line 11 from top, *read* which we were at first inclined to refer.

„ „ between lines 8 and 9 from bottom, insert *Dithyrocaris testudinea.*—Mus. Geol. Surv. Scotland, No. 1, F. $\frac{2,2}{1}$, and No. 8, F. $\frac{2,2}{8}$, counterparts, not figured. In hard, dark grey, non-calcareous shale, with the tooth-mark strong, and a trifid obscure. One piece marked Ardross, and the other Ardross Castle, Fife, Lower Limestone Group.

„ „ „ „ also insert *D. testudinea*, B. M., No. 16, not figured, is an imperfect left valve, showing both the fringed ventral margin and the dorsal crest (slightly separate), very much like Pl. XXVIII, fig. 1.

Page 151.—Woodcut. Later observations made at this quarry, which has been extended, give the following section:



The section in the quarry at Congleton Edge, where the *Dithyrocaris* and *Ceratiocaris* were found in the strata marked A*.

At the top. Grey-yellow clay, with blocks of grit: 0 to 5 feet.

A
- Decomposed limestone, crowded with crushed shells of *Orthis resupinata*: 5 ft. 2 in.
- Grit: 1 foot.
- Grey shales: 3 feet.
- Shale with half-inch bullions: 9 inches.
- Very sandy shales: 2 to 4 inches.
- Shale with slightly calcareous bullions; marine fossils: 5 ft. 7 in.
- Rather darker shale, with two lines of bullions: 3 feet.[1]

B
- Calcareous shales with *Goniatites*: 8 inches.
- Rather darker coarsely laminated shales, with *Glyphioceras spirale*, *Posidoniella lævis*, and plant remains: 1 foot.
- Shale with calcareous bullions and marine fossils: 4 feet.
- Coal: $\frac{1}{8}$ inch.

C
- Gannister grit with plant remains: 5 ft. 8 in.
- Flaggy grit with thin black shale partings: 2 feet.
- Shale: 3 to 4 inches.
- Grit (Gannister): 1 ft. 6 in. to 2 feet.
- Shale and thin grits: 1 ft. to 1 ft. 6 in.
- Grit (Gannister): 5 ft. 6 in.
- Shale much squeezed: 2 feet.
- Grit: 1 foot.
- Coal: $\frac{1}{2}$ inch.
- Grit (Gannister) with plant remains: 11 feet.
- Shale with many plants: 3 inches.
- Grit: 1 foot.
- Shale: 4 ft. 6 in.
- Grit (Gannister): 3 ft. 6 in.

[1] This is the horizon at which *Dithyrocaris testudinea* and *Ceratiocaris Oretonensis* were found.

Page 154, lines 15, 20, and 26 from bottom, for *Glyphoceras* read *Glyphioceras*.
,, ,, line 16 from bottom, for *Ortonensis* read *Oretonensis*.
,, 155 ,, 18 ,, *delete* 10 (?).
,, 156 ,, 16 from top, *add* 6—7 costulæ.
,, 156 ,, 20 from top, *add* page 149.
,, 159 ,, 10 ,, *for* species. From *read* species from.
,, ,, ,, 12 ,, *add* A fragment of a valve of *D. funiculata*, with a trace of its *marginal cord*, and a long rugose mesolateral ridge, is in the British Museum (I. 280, No. 26). It is in a thin black, micaceous, calcareous shale, consisting mainly of compressed little Ostracods, such as the shales referred to at page 164, and like some of the "oil-shales" of Scotland. From Tyrone; marked "Tyrone, Sheet 58, No. 5."
,, ,, ,, 14 ,, *for* 3 *read* 4.
,, ,, ,, 21 ,, *delete* Nos. 39 A and 44 A.
,, ,, ,, 2 from bottom, *after* mesolateral *insert* (see fig. 3 *b*).
,, 161 ,, 7 from top, *after* 39 B *add* Pl. XXX, figs. 4 *a*, *b*.
,, ,, ,, 8 ,, *for* 43 *read* 48.
,, ,, ,, 9 ,, *after* ventral *add* with some remains of the left valve.
,, ,, ,, 13 ,, *after* ridges *read* and from those of the ventral margin (fig. 4 *b*).
,, 162 ,, 3 ,, *for* 3 *b read* 3 *c*.
,, ,, ,, 10 from bottom, *after* and 9 *add* Museum of the Yorkshire College, Leeds, Nos. 43 and 40.
,, 163 ,, 6 from top, *after* oblique *insert* to the dorsal ridge at an angle of 85°.
,, ,, ,, 25 ,, *for* parallel to each other *read* divergent from each other.
,, 165 ,, 24 ,, *read* their relative position (though crushed, and obscure in the figure) and the ornamental lines on the ultimate segment indicate the *dorsal* aspect.
,, 173 ,, 22 ,, *add* In the three-spined caudal appendage the dorsal aspect is shown; for the head of the style overlaps the heads of the stylets (more clearly in the photograph than in the lithograph). The style is of a bayonet shape with a median ridge. The stylets are sulcate, with four costulæ, and have obscure indications of the bases of marginal hairs or setæ.

In Explanation of Plate XXI, line 21 from top, for *Scouleri* (?), M'Coy, read *testudinea*, Scouler.
,, ,, XXII, line 7 from top, for *Chænocaris* read *Calyptocaris*.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1887.

LONDON:

MDCCCLXXXVIII.

A MONOGRAPH

OF THE

BRITISH PALÆOZOIC PHYLLOPODA

(PHYLLOCARIDA, Packard).

BY

PROF. T. RUPERT JONES, F.R.S., F.G.S., &c.,

AND

DR. HENRY WOODWARD, F.R.S., F.G.S., &c.

PART I.

CERATIOCARIDÆ.

Pages 1—72. Plates I—XII.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1888.

PRINTED BY
ADLARD AND SON, BARTHOLOMEW CLOSE.

A MONOGRAPH

ON THE

BRITISH PALÆOZOIC PHYLLOPODA.

(PHYLLOCARIDA, *Packard.*)

INTRODUCTION.

Fossil remains referable only to organisms related to such Phyllopodous animals as *Nebalia*, *Apus*, and *Estheria* have been met with in many of the Geological Formations. Dr. Scouler, in 1835, was the first to treat of one of these fossils, namely, *Argas* (afterwards *Dithyrocaris*), having some alliance to *Apus*. Professor M'Coy, in 1848, and Mr. J. W. Salter, in 1853, described remains of some more or less *Nebalia*-like genera (*Ceratiocaris* and *Hymenocaris*). Subsequently numerous other forms, variously related to the two above-mentioned Crustaceans, have been described and figured by palæontologists at home and abroad. The history of the fossil *Estheriæ* has already been given in a Monograph published by the Palæontographical Society in 1862.

A general view of the generic characters and geological distribution of these fossil *Phyllopoda* is offered in the annexed Table. We may mention that Dr. A. S. Packard, junr., in 1879 and 1883, leaving *Estheria* among the true *Phyllopoda* (*Branchiopoda*), has referred all the other fossil forms in the accompanying list, with which he was acquainted, together with *Nebalia*, to a separate group, the *Phyllocarida* which we now propose to adopt.

TABLE OF THE KNOWN GENERA OF FOSSIL PHYLLOCARIDA.

I.—CARAPACE, UNIVALVE.

I. Flat or slightly convex Shield.

1. Neither sutured nor ridged along the back. Notched in front.

A. *Posterior border entire.*

Middle and Upper Silurian.[1]	1. *Discinocaris*, H. Woodward. 1866.	Round shield; angular notch.	(These are possibly the same.)
Triassic.	2. *Aspidocaris*, Reuss. 1867.		
Devonian.	3. ? *Spathiocaris*, Clarke. 1882.	Angular notch.	These shields differ in shape. Some of them are probably the *Aptychi* of *Goniatites*.
—	4. ? *Pholadocaris*, H. W. 1882.	Sinuous notch.	
—	5. ? *Lisgocaris*, Clarke. 1882.	Oblong notch.	
—	6. ? *Ellipsocaris*, H. W. 1882.	Rounded notch.	

B. *Posterior border slightly notched.*

—	1. ? *Cardiocaris*, H. W. 1882.	Front notch oblong.

C. *Posterior border deeply notched.*

Lower Silurian.[1]	1. ? *Pterocaris*, Barrande. 1882.	Both notches angular.	Test radiately marked.
Lower Silurian and Devonian.	2. *Dipterocaris*, Clarke. 1883.	Both notches angular.	Test ridged along the middle.
Lower Silurian.	3. ? *Crescentilla*, Barrande. 1872.	Both notches angular.	Possibly a sutured form.

2. Ridged along the back. (Like Apus.)

Devonian and Carboniferous.	1. *Dithyrocaris*, Scouler. 1843. (*Argas*, Scouler. 1835.)	Ridged and sometimes prickly.	These are possibly the same.
Carboniferous.	2. *Rachura*, Scudder. 1878.	(Only telson known.)	

3. Sutured along the back. Notched in front.

Middle and Upper Silurian.	1. *Aptychopsis*, Barrande (and H. W.). 1872.	Angular notch.
Lower Silurian.	2. *Peltocaris*, Salter. 1863.	Rounded notch.
—	3. *Pinnocaris*, R. E. Jun. 1878.	Slight notch. Striæ concentric far back.

II. Folded Shield, bent along the back (like *Nebalia*), so as to form an overarching Carapace, or a pair of attached Valves.

Lingula-flags.	1. *Hymenocaris*, Salter. 1853.	Smooth.
Lower Silurian.	2. ? '*Cytheropsis testis*,' Barrande. 1872.	Not well known.
Uppermost Devonian or Lowest Carboniferous.	3. *Protocaris*, Baily. 1872.	Not well known.

[1] In the old or Murchisonian sense.

II.—CARAPACE, BIVALVE.

I. Pod-like.

Arenig and Lingula-flags. } 1. *Caryocaris*, Salter. 1862. Pod-like; elongate, narrow, smooth.

Tremadoc, Silurian, and Devonian (America). } 2. *Ceratiocaris*, M'Coy. 1849. Pod-like; subovate, suboblong, &c.; striate.

Upper Silurian. 3. *Physocaris*, Salter. 1860. Round.

Lower Silurian. 4. *Nothozoe*, Barrande. 1872. Oval.

Carboniferous. 5. *Cryptozoe*, Packard. 1886. Suboblong.

Upper Silurian. 6. *Xiphocaris*, T, R. J. and H. W. 1886. (Only telson known.)

Carboniferous. 7. *Colpocaris*, Meek. 1872. Subovate; strongly emarginate at one end (posterior).

II. Pod-like: Oculate.[1]

Upper Silurian. 1. *Emmelezoe*, T. R. J. and H. W. 1886. Subovate.

III. With Swellings (due to internal organs) in the Antero-dorsal Region, one of which, on each Valve, may be ocular.[1]

Devonian. 1. *Echinocaris*, Whitfield. 1880. Leperditioid. Segments spinose.

Upper Silurian. 2. *Aristozoe*, Barrande. 1872. Leperditioid.

— 3. *Orozoe*, Barrande. 1872. Leperditioid.

Devonian. 4. *Elymocaris*, Beecher. 1884. Leperditioid.

— 5. *Tropocaris*, Beecher. 1884. Leperditioid. Wrinkled.

Upper Silurian. 6. *Ptychocaris*, Novák. 1885. Leperditioid. Wrinkled.

— 7. *? Phasganocaris*, Novák. 1886. (Only telson known.)

IV. With Swellings in the Antero-ventral Region; ocular tubercle not apparent.

Upper Silurian. 1. *Callizoe*, Barrande. 1872. Leperditioid.

V. Conchiferoidal; probably enclosing all the Abdominal Segments.

Tremadoc. 1. *Lingulocaris*, Salter. 1886. Modioloid, and faintly ridged.

Carboniferous. 2. *Solenocaris*, Meek. 1872. Pod-shaped, and concentrically marked.

Silurian. 3. ? *Orthonotella*, Ulrich. 1882. Oblong.

Silurian or Devonian ? } 4. *Myocaris*, Salter. 1864. Quadrangular, and ridged obliquely.

Carboniferous. 5. *Leaia*, Jones. 1862. Quadrangular, ridged obliquely, and concentrically marked.

Devonian. Carboniferous. Triassic. Rhætic. Jurassic. Neocomian. Tertiary ? Recent. } 6. *Estheria*, Rüppel. 1838. (True Phyllopod.) Like a bivalved mollusc, and concentrically marked.

[1] If the "ocular" swellings of the carapace be *eye-spots*, such a character would necessitate the removal of these forms to a separate division. But the nature of these prominences is uncertain.

The Phyllocarida.—We have long held the opinion that the expanded disc-like shields, such as *Peltocaris*, *Discinocaris*, *Aptychopsis*, and some others, were probably related ancestrally to the larval or adult forms of Phyllopods like *Apus*, *Lepidurus*, &c., whilst the relationship between the living *Nebalia* and the numerous genera of Palæozoic Pod-shrimps does not necessarily preclude us from considering these forms as still belonging to the Entomostraca, although placed in Packard's order Phyllocarida.

As to ornamentation, the concentric striæ, marking lines of growth, appear to correspond most closely in character and origin with the similar decoration observable on the valves of *Estheria*, *Limnadia*, &c., so that their absence upon the carapaces of *Apus* and *Nebalia* does not necessarily prove that shields so ornamented cannot be deemed to belong to Crustacea or even to the Phyllopoda; whilst many of the carapaces of the fossil genera, *e. g. Dithyrocaris*, *Ceratiocaris*, &c., have either concentric or anastomosing striæ covering the entire surface of their carapaces; and these forms are related to *Nebalia*, which has a smooth carapace destitute of ornamentation.

Claus and Gerstaeker are of opinion that *Nebalia* is not a *Phyllopod*. Because *Nebalia* during its embryonal life (whilst still in the egg) passes through the "Nauplius" and "Zoëa stages," which in Decapods occur partly in the free state, it has been regarded by some as a "Phyllopodiform Decapod." The *potentiality* of a form to attain to a higher existence seems to be here mistaken for *actuality*. Since it never attains a higher development, as an adult, than that of a Phyllopod, and has no retrograde metamorphosis, may we not with as equal reason regard *Nebalia* as a highly-organised *Phyllopod*, as to assert that it is a Decapod arrested at the Phyllopod stage?

All who have studied the Phyllopoda have been struck by the peculiar points of special interest to be observed in *Nebalia*.[1]

Milne Edwards, in his 'Histoire Naturelle des Crustacés' (1840), places *Nebalia* in the family *Apusidæ* among the Phyllopods; at the same time he remarks, "The *Nebaliæ* are very singular little crustaceans, which, by reason of their stalked eyes[2] and their carapace, approach the Podophthalmia; they do not, however, possess branchiæ, properly so called, but they respire by the aid of their thoracic feet, which are developed into membranaceous and foliaceous appendages. They resemble in many respects, and establish a passage between *Mysis* and *Apus*."

[1] For a very full account of *Nebalia*, see the 'Twelfth Annual Report of the United States Geological Survey,' Part I, "Geology, Palæontology, and Zoology," 8vo, 1883 (Washington), "A Monograph of the Phyllopod Crustacea of North America, with remarks on the Order *Phyllocarida*," by A. S. Packard, jun., pp. 295—592, and plates i—xxxix. Also the 'American Naturalist' for Oct., Nov., and Dec., 1882, vol. xvi, pp. 785, 861, 945; and G. O. Sars, 'Challenger Reports,' 1885 and 1887.

[2] Pedunculated eyes are also present in *Branchipus* and *Artemia*, so that the stalked eyes of *Nebalia* can scarcely be regarded as an essentially distinctive character.

Baird (1850) founded the family *Nebaliadæ*, and regarded *Nebalia* as a Phyllopod.

Prof. J. D. Dana (1853), in his great work on the Crustacea, retained the family name (*Nebaliadæ*), and he placed the family in the PHYLLOPODA.

Metschnikoff in 1865 published an abstract of his account of the development of *Nebalia Geoffroyi*, and in 1868 the full essay in the Russian language. Fritz Müller, in his 'Für Darwin,' states that Metschnikoff has observed "that *Nebalia*, during its embryonal life, passes through the 'Nauplius and Zoëa stages,' which in the Decapoda occur partly (in *Penæus*) in the free state." "Therefore," he adds, "I regard *Nebalia* as a Phyllopodiform Decapod."

In 1872 Claus gave an account, with excellent figures, of the external anatomy of *Nebalia Geoffroyi*, and in 1876 he described the internal anatomy.

In 1875 in the account of the Atlantic Crustacea of the "Challenger Expedition," Willemoes-Suhm placed the *Nebaliadæ* among the *Schizopoda*.

In 1879 Dr. A. S. Packard, jun., in the 'American Naturalist,' vol. xiii., p. 128, proposed that *Nebalia* and its fossil allies should be placed in a new order, which he proposed to name the PHYLLOCARIDA. Dr. Packard writes:

"The *Nebaliadæ*, represented by the existing genus *Nebalia*, have generally been considered to form a family of Phyllopod Crustacea. Metschnikoff, who studied the embryology of *Nebalia*, considered it to be a 'Phyllopodiform Decapod.' Beside the resemblance to the Decapods, there is also a combination of Copepod and Phyllopod characteristics. The type is an instance of a generalised one, and is of high antiquity, having been ushered in during the earliest Silurian Period, when there were (when we regard the relative size of most Crustacea, and especially of living *Nebaliæ*) gigantic forms. Such was *Dithyrocaris*, which must have been over a foot long, the carapace being seven inches long. The modern *Nebalia* is small, about half an inch in length, with the body compressed, the carapace bivalved as in *Limnadia*, one of the genuine Phyllopods. There is a large rostrum overhanging the head; stalked eyes; and, besides two pairs of antennæ and mouth-parts, eight pairs of leaf-like, short, respiratory feet, which are succeeded by swimming-feet. There is no metamorphosis, development being direct.

"Of the fossil forms, *Hymenocaris* was regarded by Salter as 'the more generalised type.' The genera *Peltocaris* and *Discinocaris* characterise the Lower Silurian Period, *Ceratiocaris* the Upper, *Dictyocaris*[1] the Upper Silurian and the lowest Devonian strata, *Dithyrocaris* and *Argas*[2] the Carboniferous Period. Our existing north-eastern species is *Nebalia bipes* (Fabricius), which occurs from Maine to Greenland.

"The Nebaliads were the forerunners of the DECAPODA, and form, we believe, the type of a distinct order of Crustacea, for which the name PHYLLOCARIDA is proposed."

[1] Of doubtful alliance.

[2] Not separate from *Dithyrocaris*.

The order Phyllocarida has been thus defined :

Phyllocarida, Packard (1879). Body long, with five cephalic, eight thoracic, and eight abdominal segments, with a thin or chitinous skin ; generally covered with a bivalved shell having a movable rostrum. Eyes pedunculated and faceted. Upon the under side of the head are two pairs of antennæ, the mandibles, and two pairs of maxillæ furnished with palpi. The body-segments are compressed, they support eight pairs of large Phyllopodiform thoracic feet. The abdomen is composed of eight large segments[1] provided with six pairs of simple swimming-feet fringed with setæ, of which the four anterior pairs are the largest, and the two posterior pairs very small. The abdomen terminates in setaceous filaments, or in a telson divided into three or more parts. (Zittel, ' Handbuch der Palaeontologie,' Munich, 1885.)

In 1880 Professor Claus, ' Lehrbuch der Zoologie,' writes, " This remarkable form (*Nebalia*) was for a long time regarded as a Phyllopod, and in many of its characters it represents a connecting link between the Phyllopoda and the Malacostraca. The structure and segmentation of the head and thorax resemble that of the Malacostraca, but the terminal region of the abdomen does not present the special form of a caudal plate or telson. In *Nebalia* we probably have to do with an offshoot of the Phyllopod-like ancestors of the Malacostraca, which has persisted to the present time." He adds, " *Nebalia* is best placed in a special group Leptostraca, between the Entomostraca and Malacostraca. The Palæozoic genera *Hymenocaris*, *Peltocaris*, &c. would have to be placed in such a group."[2]

" It is," writes Professor Claus, " in the highest degree probable that all these [Palæozoic Phyllocarida] are not true Phyllopods, but have belonged to a type of Crustacea, of which there are no living representatives, but which, taking their origin from forms allied to the lower types of Entomostraca, have prepared the way for the Malacostracan type. Such a connecting link, which has survived to the present day, we evidently find in the genus *Nebalia*."[3]

In his ' Handbuch der Palaeontologie,' Munich, 1885, Professor Dr. K. A. Zittel adopts Packard's order Phyllocarida, but places it under the Malacostraca, and between the Edriophthalmia and the Merostomata.

In his article on the Palæozoic allies of *Nebalia*, Dr. A. S. Packard, jun., thus sums up the Phyllocarida : " From our total lack of any knowledge of the nature of the limbs of the fossil Phyllocarida, we have to be guided solely by analogy, often an

[1] The abdomen is nine-jointed, unless the last somite be considered as the telson (it is post-anal). It is a long and slender segment, and bears two very long narrow setigerous cercopods, closely resembling those of the Copepoda.

[2] Claus, translated by Sedgwick (Cambridge), p. 448 (footnote) ; 8vo, 1884. The *Leptostraca* (Claus) are thus defined : " Crustacea with thin folded carapaces, mostly bivalved, under which all the thoracic rings remain as free segments " (Zittel, ' Handb. Palaeontol.,' 1885, p. 655).

[3] Claus, in ' Siebold und Kolliker's Zeitschrift,' vol. xxii, 1872, p. 329.

uncertain and delusive guide. But in the absence of any evidence to the contrary there is every reason to suppose that the appendages of the head, thorax, and abdomen were on the type of *Nebalia*, since there is such a close correspondence in the form of the carapace, rostrum, and abdomen. But whatever may be the differences between the fossil forms represented by *Ceratiocaris*, &c., they certainly seem to approach *Nebalia* much nearer than any other known type of Crustacea; they do not belong to the DECAPODA; they present a vague and general resemblance to the zoëa or larva of the Decapods, but no zoëa has a telson, though one is developed in a postzoëal stage; they do not belong to any other Malacostracous type, nor do they belong to any existing Entomostracous type, using those terms in the old sense. No naturalist or palæontologist has referred them with certainty to the Decapods or to any other Crustacean type than the Phyllopods. To this type (in the opinion of Metschnikoff and Claus, who have studied them most closely) they certainly do not belong, and thus reasoning by exclusion they either belong to the group of which *Nebalia* is a type or they are members of a lost, extinct group. The natural conclusion, in the light of our present knowledge, is that they are members of the group represented by the existing *Nebalia*." The differential characters separating them from the Decapods or any other Malacostracous type are—

1. The loosely-attached carapace, the two halves connected by an adductor muscle.

2. The movable rostrum, loosely attached to the carapace.

3. The very long and large mandibular palpus, the long slender appendage of the first maxilla, and the very long bi-ramous maxillæ.

4. The absence of any maxillipeds.

5. The eight pairs of pseudo-Phyllopod thoracic feet, not adapted for walking.

[To these we would add—*5a*. The 'telson' long and slender, with two long narrow setigerous cercopods as in the Copepoda.]

6. The animal swimming on its back.

7. No zoëa-formed larva.

The characters which separate it from the Phyllopods are—

1. Carapace not hinged; a rostrum present.

2. Two pairs of well-developed long and large multiarticulate antennæ; the hinder pair, in the male, longer than the first pair.

3. The thorax and its appendages clearly differentiated from the abdomen."[1]

Nebalia has been so long regarded as the surviving representative of those more ancient and gigantic forms of PHYLLOCARIDA, which existed in such numbers in the Cambrian and Silurian Seas, and became nearly extinct towards the close

[1] 'American Naturalist,' 1882, vol. xvi, p. 351; and 'Monograph N.-Amer. Phyllopods,' &c., 1883, pp. 447–8.

of the Carboniferous epoch, that any decision affecting its zoological position cannot be a matter of indifference to the palæontologist.

But after studying its larval development and adult structural modifications, we arrive at the fact that *Nebalia* is a more generalised type than is ordinarily to be found at the present day, "combining Copepod, Phyllopod, and Decapod-like features, with other more fundamental characters of its own" (Packard), which preclude us from regarding it as a true Malacostracan, and, although ancestrally related to that order, it nevertheless does not attain, in our opinion, to the Malacostracan grade of development.[1] The group should therefore be arranged in a distinct order (the PHYLLOCARIDA) between the ENTOMOSTRACA and the MALACOSTRACA, as suggested by Claus. But if it is undesirable to have such an outstanding group, then we contend that the balance turns in favour of retaining it in the former division, if not in the order PHYLLOPODA as heretofore.

Thus we conclude—

1. Some of the supposed "Phyllopod shields" from the Eifel and elsewhere are probably *Aptychi* of *Goniatites*.

2. That for others of the Palæozoic Phyllopods, described in our Reports of 1883-84 (British Association), this explanation is inadmissible.

3. That those which cannot be referred to *Aptychi* are still, in all probability, Phyllopods (Phyllocarids).

4. That the *Nebalia*-like forms, now placed in the order PHYLLOCARIDA, are *certainly not Decapods*. And even if they may not with propriety be retained any longer in the old order PHYLLOPODA (of which we are by no means sure), yet they may more correctly be placed beside them in the ENTOMOSTRACA than in the MALACOSTRACA, seeing they have not actually attained to the grade of the latter, but only approached to its larval development; whilst with the former the adult *Nebalia* has many very strong points of affinity.

CERATIOCARIDÆ.—Dr. Packard's observations on the structure of the Phyllopods, and his studies of the comparative anatomy of living and fossil forms, supply the palæontologist with sound reasoning in referring the *Phyllocarida* to the Nebaliad type as a centre for a great group of obscure fossil forms, and as a starting-point for the Decapoda. We have referred to his views in some detail in the foregoing pages, and it is our present intention to treat of the group typified by CERATIOCARIS, which has more than others a strict alliance to the recent *Nebalia*.

[1] Dr. Packard writes "There is little to indicate that the Schizopods (*Mysis*, &c.) have descended from a *Nebalia*-like form, but rather from some accelerated zoëa form; while the Phyllocarida *have had no Decapod blood in them*, so to say, but have descended by a separate line from Copepod-like ancestors, and culminated, and even began to disappear, before any Malacostraca, at least in any numbers, appeared" ('American Naturalist,' 1882, vol. xvi, p. 873). In his "Report on the Schizopoda collected by the Challenger," 1885, and "On the Phyllocarida," 1887, Prof. G. O. Sars treats of *Nebalia* as being not a true Phyllopod, but a "*Copepodiform Branchiopod*;" p. 5.

In describing the parts in the fossil forms, we have to deal with—

1. The two *valves* of the *carapace*, and the *rostrum* in front between them (rarely present). Their *ventral rim*, *raised*, and occasionally *pitted* with the bases of lost *setæ* or *prickles*. Their superficial *ornament*. In some allied forms *tubercles* or *nodes* are present, one of which may be distinguished as an *optic tubercle* or *eye-spot;* while others are due to the *maxillæ* (*teeth*), or other mouth-organs, or to places of attachment for the *buccal muscles* of the masticatory apparatus. The *cephalic region* of the valve is sometimes marked off from the *thoracic* by a slight *sulcus* (the *nuchal furrow?*).

2. The *somites* or *abdominal segments* vary in number; some are covered by the carapace, others exposed. Their *articulation; superficial ornament;* occasional *prickles;* their appendages (*uropods*) rare; and *terminal spines*. The *ultimate segment* has its own special characteristics.

3. The *caudal appendages* or *spines*, consisting of a median *telson*[1] (*urosome*) or *style*, and two smaller lateral *stylets* or *cercopods*. Their *ridges* and *furrows*, and *pits*, indicating bases of little spines or spinules, former *setæ*, *fringes*, or *fimbriæ*. The *proximal end of the telson* has often its special ornamentation.

Genus Ceratiocaris, *M'Coy*, 1849.

1839. *Onchus*, Agassiz (in part). In Murchison's 'Silurian System,' p. 607.
1848. — Phillips (in part). 'Mem. Geol. Surv.,' vol. ii, Part 1, p. 226.
1849. *Pterygotus*, M'Coy. 'Ann. Mag. Nat. Hist.,' ser. 2, vol. iv, p. 394.
1849. *Ceratiocaris*, M'Coy. 'Ann. Mag. Nat. Hist.,' ser. 2, vol. iv, p, 412.
1851. *Ceratiocaris*, M'Coy. 'Brit. Palæoz. Fossils,' Fasc. 1, p. 136.
1851. *Pterygotus*, M'Coy. 'Brit. Palæoz. Fossils,' Fasc. 1, p. 175.
1851. *Leptocheles*, M'Coy. 'Brit. Palæoz. Fossils,' Fasc. 1, p. 176.
1851. *Pterygotus* (*Leptocheles*), Bronn. 'Lethæa Geognost.,' vol. i, Part 1, p. 40.
1852. *Onchus*, James Hall. 'Geol. Surv. New York, Palæontology,' vol. ii, p. 320.
1852. *Ceratiocaris*, Bronn. 'Lethæa Geogn.,' vol. i, Part 2, p. 539.
1853. *Dithyrocaris*, Geinitz. 'Verst. Grauwack. Sachsen,' Heft ii, p. 23.
1853. *Leptocheles*, M'Coy. 'Quart. Journ. Geol. Soc.,' vol. ix, p. 13.
1853. *Ceratiocaris* (*Leptocheles*), Barrande. 'Neues Jahrb. für Min.,' &c., 1853, Heft iii, p. 342.
1853. *Dithyrocaris?*, D. Sharpe. 'Quart. Journ. Geol. Soc.,' vol. ix, p. 158.
1854. *Ceratiocaris et Leptocheles*, Murchison. 'Siluria,' 1st. edit., p. 236.
1854. *Ceratiocaris*, Morris. 'Catal. Brit. Foss.,' 2nd edit., p. 102.
1856. — Salter. 'Quart. Journ. Geol. Soc.,' vol xii, p. 33.

[1] This is really the last joint (somite) of the abdomen.

1859. *Ceratiocaris*, James Hall. 'Geol. Surv. New York, Palæntology,' vol. iii, p. 240.
1859. — Salter. In Murchison's 'Siluria,' 2nd edit. (3rd, including 'Sil. Syst.'), pp. 262, 538.
1860. — Salter. 'Ann. Mag. Nat. Hist.,' ser. 3, vol. v, p. 158.
1863. — James Hall. 'Sixteenth Ann. Rep. of the Regents, State Cabinet, New York,' p. 72, pl. 1.
1865. — J. W. Salter and H. Woodward. 'Catal. and Chart of Foss. Crustacea,' p. 17.
1865. — H. Woodward. 'Geol. Mag.,' vol. ii, p. 401.
1865. — Huxley and Etheridge. 'Catal. Foss. Mus. Pract. Geol.,' p. 79.
1866. — H. Woodward. 'Geol. Mag.,' vol. iii, p. 203.
1866. — Salter. 'Mem. Geol. Surv.,' vol. iii, p. 294.
1867. — Salter. In Murchison's 'Siluria,' 3rd. edit. (4th, including 'Sil. Syst.'), pp. 236 and 516.
1868. — Bigsby. 'Thesaurus Siluricus,' p. 73.
1871. — H. Woodward. 'Geol. Mag.,' vol. viii, p. 104.
1872. — H. Woodward. 'Geol. Mag.,' vol. ix, p. 564; and 'Report Brit. Assoc.' for 1872, p. 323.
1872. — Barrande. 'Syst. Sil. Bohême,' vol. i, Suppl., p. 437.
1873. — Salter. 'Cat. Cambr. and Sil. Foss. Woodw. Mus.,' p. 177.
1873. — R. Etheridge, junr. 'Mem. Geol. Surv. Scotl., Expl. Map 23,' p. 93.
1873. — Marschall. 'Nomenclator Zoologicus,' p. 404.
1874. — R. Etheridge, Junr. 'Ann. Mag. Nat. Hist.,' ser. 4, vol. xiv, p. 9.
1876. — Ferd. Roemer. 'Lethæa geognost,' Theil i; 'Leth. palæozoica,' Explanation of pl. 19.
1877. — H. Woodward. 'Catal. Brit. Foss. Crust.,' p. 70.
1877. — Miller. 'Catal. Palæoz. Foss. America,' p. 213.
1878. — Huxley, Newton, and Etheridge. 'Catal. Foss. Mus. Pract. Geol.,' p. 84.
1878. — Bigsby. 'Thes. Devonico-Carbonif.,' pp. 26, 246 and 247.
1878. — Young. 'Proceed. Roy. Phys. Soc. Edin.,' vol. iv, p. 168.
1880. — Whitfield. 'Amer. Journ. Sci.,' ser. 3, vol. xix, p. 35.
1882. — B. N. Peach. 'Trans. Roy. Soc. Edin.,' vol. xxx, part 1, p. 73.
1883. — A. S. Packard, junr. 'Monogr. North-Amer. Phyllop. Crust.; Twelfth Ann. Rep. U.S. Geol. and Geograph. Survey,' p. 450.

1883. *Ceratiocaris*, Fr. Schmidt. 'Mém. Imp. Acad. Sci. St.-Pétersb.,' ser. 7, vol. xxxi, p. 84.
1883. — T. R. J. and H. W. 'Report Brit. Assoc. for 1883,' p. 217.
1884. — C. E. Beecher. "Ceratiocaridæ Upper-Devonian Measures," 'Second Geol. Surv. Pennsylvania, P.P.P.,' p. 2.
1884. — T. R. J. and H. W. "Second Report on Palæoz. Phyllop.," 'Report Brit. Assoc. for 1884,' p. 95.
1884. — T. R. J. and H. W. 'Geol. Mag.,' dec. 3, vol. i, pp. 356, 396.
1885. — O. Novák. 'Sitzungsb. k. böhm. Gesellsch. Wissensch.,' Jahrg. 1885, p. 239.
1885. — T. R. J. and H. W. 'Third Report Pal. Phyll., Brit. Assoc. for 1885,' p. 334.
1885. — H. Woodward. 'Geol. Mag.,' dec. 3, vol. ii, p. 349.
1885. — T. R. J. and H. W. Ibid., pp. 385 and 460.
1885. — J. M. Clarke. 'Geolog. Succession in Ontario Co., New York,' pp. 18 and 20.
1886. — T. R. J. and H. W. 'Fourth Report Pal. Phyll., Brit. Assoc. for 1886,' p. 229.
1886. — T. R. Jones. 'Geol. Mag.,' dec. 3, vol. iii, p. 456.

The generic characters of *Ceratiocaris* have been described by M'Coy, Salter, H. Woodward, and Barrande in their several works and memoirs referred to above and in the sequel. James Hall, R. P. Whitfield, A. S. Packard, J. M. Clarke, Fr. Schmidt, C. E. Beecher, O. Novák, and others have added much information, general and special, on this and allied genera. The foregoing synonymy of the genus supplies references to published observations on *Ceratiocaris* and some of its allies.

We offer the following diagnosis of *Ceratiocaris*. Carapace bivalved, probably with membranous attachment, no distinct hinge-joints being observable; valves subovate, semiovate, subquadrate, or trapezoidal; contracted in front, with the end sharp or rounded above the median line of the valve; more or less truncate behind. Rostrum elliptical in shape, of a single lanceolate piece, chevron-marked. Antennæ (?) obscure. Maxillæ often apparent. Body many-jointed, with fourteen or more segments, of which 4—7 extend beyond the carapace, ornamented with delicate raised lines. Some or all of these segments bore small lamelliform branchial appendages.[1] Last segment the longest, supporting three caudal spines, namely: (1) a strong tapering telson (style), thick at the top or proximal end, usually with a trilobed articulating surface (resembling that in the telson of *Limulus*), pointed at the other, and more or less spinose, as shown by the bases of little prickles; and (2) two shorter, simpler, lateral appendages (stylets). The surface

[1] See the "Sixth Report on Fossil Crustacea," 'Brit. Assoc. Rep. for 1872,' p. 323.

of the valves has a linear ornament, and the ventral margin has a thin raised rim, furnished, in some instances, with small tubercles or a fine spinose fringe.

Respecting the abdominal appendages which Mr. R. Etheridge, jun., described in Appendix III of the 'Memoirs Geol. Survey Scotland, Explanation of Sheet 23,' 1873, p. 93, he there remarks:

"A further advance in the structure of this genus of Crustacea has been satisfactorily established from specimens obtained at Lesmahagow by the Collector of the Geological Survey, viz. the presence of respiratory locomotive appendages. On a slab of thin-bedded shale are exposed the abdominal segments, telson, and caudal appendages of a *Ceratiocaris*. From the ventral margin of the terminal segment, to which are attached the telson-spines (*Leptocheles*, M'Coy), proceeds a broad, paddle-shaped, membranous (?) expansion, presenting a strong marginal outline, with a transversely striated surface. This is followed by another similar appendage, proceeding in the same manner from the penultimate segment (somite). Along the dorsal margin there is seen what appears to be the remains of one of the corresponding 'foot-gills,' on the other side, bent back upon itself, and thus thrust out of place. The free ends of these foot-gills are attenuated to more or less rounded points. They do not show any evidence of having possessed a marginal fringe. The discovery of these branchial locomotive appendages tends to ally *Ceratiocaris* still further with the genus *Nebalia*. See 'Geol. Mag.,' vol. ix, p. 564. *Loc.:* No. 292 (Linburn or Linn Burn, about two miles north of Muirkirk, Lanarkshire). In thin-bedded shale (Upper Ludlow). Collected by A. Macconochie."

Fig. 1.

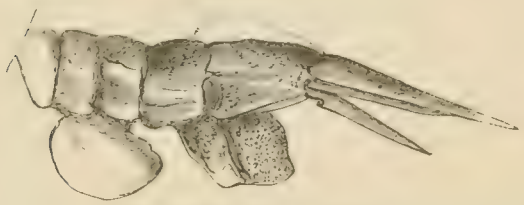


Fig. 2.

Fig. 1.—Abdominal segments and caudal spines of *Ceratiocaris stygia*, with indications of branchial lamellæ or uropods, Geol. Surv. Mus. Edin., M. 101, Linburn.

Fig. 2.—Abdominal segments and caudal spines of *Ceratiocaris papilio*, with indications of uropod, Geol. Surv. Mus. Edinb., M. 94, Linburn

Mr. R. Etheridge, jun., again alludes to this interesting subject in the 'Annals and Mag. Nat. Hist.' ser. 4, vol. xiv, 1874, p. 9.

Some of the abdominal segments seem to exhibit joint-marks or surfaces of articulation adapted for appendages rather than for union with the next somite. Compare Pl. III, fig. 3.

Ceratiocaris leptodactylus (M'Coy) and *C. Murchisoni* (Agassiz), having been the first recorded species, will be here described first.

The following is a list of the British Palæozoic Ceratiocaridæ and allies, as at present known, and treated of in this portion of the Monograph.

	PLATES
1. *Ceratiocaris leptodactylus*, M'Coy.	VI, X
2. — *Murchisoni*, (Agass.),	III, IV, V, VI
3. — *valida*, T. R. J. & H. W.	VI
4. — *tyrannus*, Salter.	III, IV, V, IX
5. — *gigas*, Salter.	III, IV, V
6. — *Halliana*, T. R. J. & H.W.	II, IV, V
7. — *Pardoëana*, La Touche.	V
8. — *canaliculata*, T. R. J. & H. W.	IX
9. — *Ludensis*, H. W.	I, IX
10. — *papilio*, Salter.	XI, XII
11. — *stygia*, Salter.	X, XI, XII
12. — *longa*, sp. nov.	VI, XI
13. — *robusta*, Salter.	X, XI
14. — *patula*, sp. nov.	XI
15. — *angusta*, T. R. J. & H. W.	X
16. — *minuta*, T. R. J. & H. W.	X, XI
17. — *inornata*, M'Coy.	X
18. — *Ruthveniana*, T. R. J. & H. W.	X
19. *Ceratiocaris Oretonensis*, H. W.	X
20. — *truncata*, H. W.	X
21. — *solenoides*, M'Coy.	VIII
22. — *gobiiformis*, T. R. J. & H. W.	VIII
23. — *Salteriana*, T. R. J. & H. W.	VII
24. — *laxa*, T. R. J. & H. W.	VIII, X
25. — *compta*, T. R. J. & H. W.	VII
26. — *cassia*, Salter.	VII
27. — *cassioides*, T. R. J. & H. W.	III, IV, VII
[28. *C.? longicauda* (Sharpe), Portuguese].	XI
29. *C. decora*, Phillips.	
30. *C.? lata*, Salter.	
31. *C.? insperata*, Salter.	
32. *C.?* sp.?	
33. *C.? perornata*, Salter.	
1. *Xiphocaris ensis* (Salter).	V
1. *Physocaris vesica*, Salter.	VII

Oculate Forms.

1.	*Emmelezoe elliptica* (M'Coy).		VIII
2.	—	*crassistriata*, T. R. J. & H. W.	VIII
3.	—	*tenuistriata*, T. R. J. & H. W.	VII
4.	—	*Maccoyiana*, T. R. J. & H.W.	VIII

In acknowledging the obligations we owe to numerous friends who have aided us in becoming acquainted with all the specimens illustrative of the above-mentioned species, we must refer to the names associated with them in our descriptions; also to the Officers of the several Museums from which we have been granted the loan of specimens to draw and describe. We cordially thank the Artists for the care shown in so admirably illustrating this Monograph.

Note.—The specimens indicated in this Monograph as Oxford Museum A—U, and those indicated as Ludlow Museum A—U, were examined and so marked by us in those Museums. Those in the Cambridge Museum, the British Museum, and the Museum of Practical Geology are indicated in this Monograph by the labels attached to them in those collections.

1. Ceratiocaris leptodactylus (*M'Coy*), 1849. Plate VI, figs. 4 *a*, 4 *b*, 4 *c*, 5, 6 (?), 7, 8, 9, and Pl. X, fig. 8 (?).

1849.	Pterygotus leptodactylus, *M'Coy*.			Ann. Mag. and Nat. Hist., ser. 2, vol. iv, p. 394.
1851.	—	—	—	Synops. Brit. Palæoz. Foss., Fasc. i, p. 176, pl. 1 E, figs. 7, 7*a*, 7*b* (not figs. 7*c*, 7*d*).
1853.	Leptocheles	—	—	Quart. Journ. Geol. Soc., vol. ix, p. 13.
1859.	—	—	*Murchison*.	Siluria, 2nd (3rd) ed., p. 263, 538.
1860.	Ceratiocaris	—	*Salter*.	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 157.
1867.	Leptocheles (Ceratiocaris) leptodactylus, *Salter*.			In Siluria, 3rd (4th) ed., p. 237.
1867.	Ceratiocaris leptodactylus, *Salter*.			Ibid., p. 516.
1873.	—	—	—	Catal. Camb. Sil. Foss., p. 164.
1877.	—	—	*H. Woodward*.	Catal. Brit. Foss. Crust., p. 71.
1878.	—	Murchisoni (part), *Huxley, Newton & Etheridge*.		Catal. Foss., M. P. G., p. 84.
1885.	—	leptodactylus, *T. R. Jones & H. Woodward*.		Third Report on Palæoz. Phyllop., Brit. Assoc. Rep., p. 339; Geol. Mag., dec. 3, vol. ii, p. 388.
1886.	—	—	—	Fourth Rep., Brit. Assoc. Rep., p. 229; Geol. Mag., dec. 3, vol. iii, p. 456.

Some imperfect specimens (Cambridge Museum, *a*/923 and *a*/924) of the delicate caudal appendages of a *Ceratiocaris* (Pl. VI, figs. 4, 5) from Leintwardine, in Shropshire,[1] were referred by Prof. M'Coy at first to a chelate limb of *Pterygotus*, and then to that of a different but allied genus (*Leptocheles*). Ultimately Mr. Salter gave them their true place in *Ceratiocaris*. In 1877 this species was grouped with *C. Murchisoni* in the 'Catalogue of British Fossil Crustacea,' p. 71; and it was regarded as a variety of that species, also, in our 'Third Report on Palæozoic Phyllopoda,' 1885, pp. 336—339. We now find, however, that it is different both as to size and proportion; and we have detected two rows of little

[1] The very rich localities for Silurian Phyllopods in the neighbourhood of Ludlow are enumerated and described in the Rev. J. D. La Touche's 'Manual of the Geology of Shropshire,' 1884, pp. 26, 27, especially Ludford Lane, Bow Bridge, Leintwardine, Church Hill, and Trippleton Farm. In his 'Record of the Rocks,' 1872, p. 124, &c., the Rev. W. S. Symonds notices Ludlow and its environs from a geologist's point of view. See also 'Siluria,' 1867, chap. vii, pp. 123, *et seq.*

pits, which were the bases of setæ, on the exposed surface of one of the specimens in the University Museum at Cambridge (Pl. VI, fig. 4 *b*).

In each case we have only caudal spines to deal with; but M'Coy's specimens ('Brit. Pal. Foss.,' pl. 1 E, figs. 7, 7 *a*, 7 *b*) are much more slender than Murchison's ('Sil. Syst.,' pl. 4, figs. 10 and 64, and 'Siluria,' last edit., pl. 19, figs. 1, 2), and less strongly ribbed; and therein they have specific differences.

Some similar caudal appendages (Mus. Pract. Geol. $\frac{17}{14}$) occur in the Lower-Wenlock Rock of Helm Knot, Dent, Yorkshire. Some doubtful fragments of ultimate segments of the abdomen are shown in Pl. VI, fig. 6, and Pl. X, fig. 8.

In 1860 Mr. Salter apportioned to this species a certain kind of carapace which we think belongs to a new species (*C. Halliana*, which see further on).

Pl. VI, figs. 4 *a*, 4 *b*, 4 *c*. Cambridge Museum *a*/924. Described and figured by M'Coy, 'Brit. Pal. Foss.,' 1851, pl. 1 E, figs. 7 and 7 *b*, as *Pterygotus leptodactylus*, from Leintwardine. This specimen is in faintly greenish-grey mudstone, slightly calcareous along thin seams at the edge. It consists of a small fragment (smaller than when figured by M'Coy) of the distal (lower) end of an ultimate segment, longitudinally striate, and a ridged telson. The latter, not fully exposed at the end, retains portions of its test; some of these pieces, low down, are small, but the proximal portion or head of this telson is well characterised by its leaf-marked or latticed test (4 *a*, 4 *c*). The junction of segment and telson have been disturbed by pressure.

The outer ridge of the telson and the third ridge inwards bear numerous marks of the bases of small prickles (figs. 4 *a*, 4 *b*, 4 *c*). Whether the outer edge represents the back or the side of the dorsal ridge (that is, if it bore more than the one visible row of marks) is doubtful; the telson may have had a double row of prickles along its back, one on each side of the ridge. The inner row on the third ridge is an interesting and special feature.

Figure 5 (Cambridge Museum *a*/923). Described and figured by M'Coy ('Brit. Pal. Foss.,' pl. 1 E, fig. 7 *a*). In olive-grey sandstone, not calcareous. From Leintwardine. A longitudinally ridged telson, badly preserved, but retaining a striated fragment of ferruginous crust.

Pl. VI, figs. 6, 7, 8, 9. Museum Practical Geology $\frac{17}{14}$, $_{1,2,3,4.}$ Labelled "C. Murchisoni, M'Coy, Coniston Grit.,[1] Helm Knot, Dent, Yorkshire. Collected by Prof. M'K. Hughes." See also 'Catal. Cambr. Silur. Fossils,' 1878, p. 84, and 'Geol. Mag.' vol. iii, p. 205. Hard, olive-green, and brownish mudstone, not calcareous, with poorly-preserved ferruginous impressions.

Fig. 6. Probably part of an ultimate segment, longitudinally striated. The obscure, irregular, deeper, and continuous hollow may possibly have reference to a telson.

Fig. 7. A style (broken) and two stylets. All ridged throughout; the first

[1] Equivalent to the "Wenlock Shale" (Lower Wenlock).

bearing indications of two rows of the bases of prickles on its upper portion, and thus corresponding with fig. 4; it is imperfect at the end. The others are probably perfect in length.

Fig. 8. A similar, but smaller, set of caudal appendages; all ridged; only the style retaining its full length.

Fig. 9. Style and stylets pressed together. The end of the former is still in the matrix. Some indistinct traces of spine-bases are seen on its lower portion, but not represented in the drawing.

Pl. X, fig. 8 (British Museum 44342). Benson Knot,[1] Kendal. Dark grey sandstone, somewhat micaceous, and slightly calcareous.

C. LEPTODACTYLUS.—*Carapace.*—Not known.
Ultimate Segment.—With longitudinal anastomosing wrinklets.
Caudal Appendages.—Slender, ridged and fluted.
Head of Telson.—With lattice ornament and anastomosing longitudinal wrinklets.
Style (*telson*).—Fluted, and pitted in two rows on the side (as exposed).
Stylets.—Delicately fluted.

Length of	Fig. 4.	Fig. 5.	Fig. 7.	Fig. 8.	Fig. 9.
Style.....	65 mm. (imperfect).	65 mm.	50 mm. (broken).	40 mm.	50 mm. (imperfect).
Stylet.....	—	—	55 mm.	—	28 mm.

A specimen in the Museum of Practical Geology, marked D $\frac{2\,2}{1\,3}$ ('Catal. Cambr. and Sil. Fos., M. P. G.,' 1878, p. 118), from Dudley, a thin curved telson (?), delicately striate, is probably *C. leptodactylus*.

In Barrande's 'Syst. Sil. Bohème,' vol. i, Supp., pl. 19, figs. 14—16 of *C. inæqualis* are comparable with *C. leptodactylus*.

2. CERATIOCARIS MURCHISONI (*Agassiz*), 1839. Pl. III, figs. 4 *a*, 4 *b*, 7; Pl. IV, figs. 1 and 3; Pl. V, fig. 3; Pl. VI, figs. 1 and 2.

1839. ONCHUS MURCHISONI, *Agassiz*. In Silur. Syst., p. 607, pl. 4, fig. 10 (not figs. 9 and 11); and *Onchus*, fig. 63 ?, and Ichthyodorulite, fig. 64.
1851. LEPTOCHELES (MURCHISONI), *M'Coy*. Synops. Brit. Pal. Foss., Fasc. 1, p. 176.
1853. — MURCHISONI, — Quart. Journ. Geol. Soc., vol. ix, p. 13 (omitting allusion to figs. 9 and 11, Sil. Syst.).
1853. DITHYROCARIS — *Geinitz*. Verstein. Grauwackenformation in Sachsen, Heft ii, p. 24, pl. 19, fig. 13.

[1] "The micaceous flags of Benson Knot belong to what are locally called 'Kirkby-Moor Flags'—*i. e.* Upper Ludlow."—Prof. T. M'K. Hughes, 'Geol. Mag.,' vol. iii, p. 208.

1854.	Leptocheles Murchisoni,		*Murchison.*	Siluria, 1st ed., p. 236, pl. 19, figs. 1, 2.
1859.	—	—	—	Siluria, 2nd ed. (3rd, including Sil. Syst.), pp. 263, 538, pl. 19, figs. 1, 2.
1860.	Ceratiocaris	—	*Salter.*	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 157.
1866.	—	—	*Jones.*	Ibid., ser. 3, vol. xviii, p. 40.
1866.	—	—	*H. Woodward.*	Geol. Mag., vol. ii, p. 205, pl. 10, figs. 8, 9.
1867.	Leptocheles	—	*Salter.*	In Siluria, 3rd. ed. (4th ed., including Sil. Syst.), p. 134, pl. 19, figs. 1, 2.
1867.	—	(Ceratiocaris) Murchisoni,	*Salter.*	Ibid., p. 237, pl. 19, figs. 1, 2.
1867.	Ceratiocaris Murchisoni,		*Salter.*	Ibid., p. 516, pl. 19, figs. 1, 2.
1877.	—	—	(part), *H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1878.	—	—	— *H. N. & E.*	Catal. C. S. Foss., M. P. G., pp. 84, 168.
1878.	—	tyrannus	— —	Ibid., p. 118.
1885.	—	Murchisoni (part),	*T. R. J. & H. W.*	Third Rep. Pal. Phyllop., Brit. Assoc., p. 339; Geol. Mag., Sept., 1885, p. 387.
1886.	—	—	*T. R. J. & H. W.*	Fourth Rep., Brit. Assoc., p. 229; Geol. Mag., Oct., 1886, p. 456.

Some imperfect caudal appendages or spines (telson or style, and lateral spines or stylets) from the Uppermost Ludlow strata, near Ludlow, were figured in Murchison's 'Silurian System,' in 1839, as fish-defences. These were recognised by Prof. F. M'Coy in 1853 as being very similar to some analogous fossils, referred by him at first (in 1849) to a slender-clawed kind of *Pterygotus* from the Lower Ludlow, at Leintwardine, near Ludlow, but which he afterwards separated from that genus as *Leptocheles leptodactylus*. M'Coy suggested that Murchison's fossil should be known as *L. Murchisoni*.

Prof. M'Coy's observations are as follows:—". . . . . As before mentioned, figs. 9, 10, and 11 ['Sil. Syst.,' pl. 4; omit figs. 9 and 11], representing the so-called *Onchus Murchisoni*, Ag., are almost identical in form, size, sculpturing, and all other characters (as far as they are represented in these drawings), with the distinctly didactyle pincers which I have figured ('Brit. Pal. Foss.,' pl. E, fig. 7) from Leintwardine, under the name *Lept. leptodactylus*. . . . . If this approximation prove correct, the fossil should in future be called *Leptocheles Murchisoni* (Ag. sp.)." 'Quart. Journ. Geol. Soc.,' vol. ix, 1853, p. 13.

C. Murchisoni, founded on the specimens figured in 'Sil. Syst.' and 'Siluria,' but now unfortunately mislaid, is represented by several analogous fossils, such as Oxford Museum B and C; Ludlow Museum C; M. P. G. $\frac{2\,3}{3\,3}$ and $\frac{2\,3}{3\,6,\,1}$. We find only one row of pits on the styles, as exposed. We have been unable to determine its carapace. The carapaces assigned by Salter to *C. leptodactylus* and *C. Murchisoni* are not accepted by us. We formerly thought that they belonged to one species, but now regard them as distinct.

Several good examples of more or less perfect sets of three caudal spines, corresponding in size, strength, curvature, and ribbing with Murchison's fossils, have been met with. Some of these show evidence of lines of prickles (by the presence of little pits, representing their bases), and on close examination the engravings in the 'Sil. Syst.' and 'Siluria' (the specimens have been mislaid) show some slight indications of this spinose ornament.

We have not found a carapace directly associated with any tail-spines of either the *Murchisoni* or the *leptodactylus* type. With regard to both however, the late Mr. J. W. Salter satisfied himself that he knew their special carapaces, for he described them at p. 157 of the 'Ann. Mag. Nat. Hist.' for March, 1860, where also he refers both species to the *Ceratiocaris* of M'Coy. Judging from his Latin diagnoses, he allocates to the former "a cephalothorax (carapace) two inches long, oblong, convex, ornamented with interrupted, nearly straight, wide-apart lines. The caudal appendages long, sub-cylindrical; the central spine (telson) strong, bulbous at its base, and with a strong dorsal rib; the side spines long. All ribbed. The whole animal medium-sized. Specimens possessed by the geologists at Ludlow and by the Museum of Practical Geology." The carapace described here does not agree with any that we can associate with the caudal spines intended.

Pl. III, fig. 4 *a*. Four body-segments with outside test, and impressed caudal spines. Ornamentation consisting of longitudinal, abrupt, delicate wrinklets; and on the head of the crushed telson strong leaf-like anastomosing lines. Fig. 4 *b*. A segment, magnified, showing the ornament.

Mus. Pract. Geol.; one of those marked "$\frac{2\,3}{3\,3}$. *C. tyrannus*, Salter." 'Catal.,' 1878, p. 118. Leintwardine. In brownish-grey mudstone.

Pl. III, fig. 7. Two stylets, irregularly rugose (probably decomposed). Mus. Pract. Geol. "$\frac{2\,3}{3\,3}$. Wyatt-Edgell Collection, 1878. Lower Ludlow; Leintwardine. *Ceratiocaris Murchisoni*, M'Coy." See 'Catal.,' p. 118. In darkish olive-grey micaceous mudstone.

Pl. IV, fig. 1. Head of telson leaf-marked, crushed; top of stylet with rounded head, in place: the rugosities on the stylets are probably due to decomposition. There are some regular pittings on the style (=4 inches=105 mm.), which is ridged, as also are the stylets. Oxford Museum B. In brownish-grey mudstone; Lower Ludlow. Marked "*Murchisoni*."

Pl. IV, fig. 3. A set of caudal appendages, imperfect at the ends. One semicircular acetabulum on the telson head for articulation with the angle of the ultimate segment, and the other (below) for a stylet (broken across its neck), are well shown. Pitting present on the style; none on stylets. Style and stylets ridged and fluted. Oxford Museum C. Lower Ludlow. Olive-grey sandstone.

Pl. V, fig. 3. A style (telson) and a stylet, both having longitudinal smooth ridges, partly preserved. The telson seems at first sight to show five ridges, but there are really two main lateral ridges, one delicately keeled for part of its length, and the other (nearer the dorsum) is deeply fluted, and in the furrow is a series of small sub-oval pits, each with a central nipple, the bases of former prickles. In greenish-grey mudstone, not quite uniform in texture, and mottled with brownish patches; calcareous in parts. Ludlow Museum C. Lower Ludlow. Church Hill, Leintwardine. Collected by Mr. H. Pardoe. This specimen C (fig. 3) was cemented to B (Pl. V., fig. 1), and labelled "*Ceratiocaris Pardoensis*," in the Ludlow Museum, but they do not correspond, being exposed with different aspects, and not agreeing in size and proportions.

Plate VI, figs. 1 and 2. Copied from 'Siluria,' 3rd edition (published as the 4th, including the 'Silurian System'), 1867, pl. 19, figs. 1 and 2, which had been transferred as lithographs from the engravings in the 'Silurian System,' 1839, pl. 4, figs. 10 and 64, to 'Siluria,' 1st edition (published as the 2nd), 1854, pl. 34, fig. 1, and pl. 35, fig. 13.

Fig. 1. 'Siluria,' 1854, *Leptocheles*, pl. 19, fig. 1; 1867, pl. 19, fig. 1. 'Silurian System,' 1839, *Onchus*, pl. 4, fig. 10, said to be from the Uppermost Ludlow Beds ("the Downton series") at the Tin Mill, Ludlow. Fragments of a style (telson) and two stylets, all ridged and furrowed. The broken piece lying obliquely at the top is evidently a part of the style, and not of a stylet, as its end lies upon the former. Some small spots at the lower end of the style possibly indicate the bases of prickles.

Fig. 2. 'Sil. Syst.,' 1839, Ichthyodorulite, pl. 4, fig. 64; 'Siluria,' 1854, *Leptocheles*, pl. 19, fig. 2; 'Siluria,' 1867, pl. 19, fig. 2. Fragment (proximal end) probably of a ridged style, its shape modified by embedment. A line of dots seems to be referable to the bases of prickles.

C. Murchisoni.—*Carapace.*—Not known.

Segments.—Straight wrinkles passing backwards into lattice-pattern at the edge.

Appendages.—Long and strong, slightly curved, convexity dorsal.

Telson.—Ridged and fluted, pitted along two rows (one on each side); slightly curved downwards.

Telson-head.—Irregular wavy striæ with partial lattice-work ornamentation.

Stylets.—Ridged and fluted.

Length of	Pl. III, fig. 4.	Pl. III, fig. 7.	Pl. IV, fig. 1.	Pl. V, fig. 3.	Pl. VI, fig. 1.
Style.....	90 mm. (not perfect).	—	105 mm. (not quite perfect).	116 mm. (imperfect).	105 ? mm. (imperfect).
Stylet.....	—	75 mm.	64 mm.	—	—

The following specimens belong to *C. Murchisoni:*

1. A good specimen of three segments and three caudal spines from the Wenlock Shale of Cwm-y-sul, near Welshpool, in the collection of J. Bickerton Morgan, Esq., of Welshpool.

2. A somewhat similar specimen in the Owens College, Manchester. No locality.

3. Also, in the same Museum, part of some caudal appendages marked "A. L., opposite New Bridge." Greenish calcareous mudstone. Lightbody Coll.

4. Another in Owens College is a piece of a straight ridged style, marked "U. L. Whitcliffe wd."

5. In Owens College a somewhat similar fragment in greenish, micaceous mudstone, with casts of *Beyrichia Wilckensiana* and of small *Primitiæ*, is labelled "By fish-bed; Ludford Lane."

6. Oxford Museum P is a small fragment of a telson strongly ridged, said to be from Upper-Ludlow Beds of Usk, in squeezed, imperfectly cleaved, olive-grey mudstone, with small Brachiopods.

7. Ludlow Museum T comprises the large part of a style and fragment of a stylet. From the Lower-Ludlow beds of an old roadside quarry at Trippleton Farm, one mile from Leintwardine, Shropshire. Lightbody Coll.

8. Numerous small pieces of ridged caudal spines occur in the Upper Ludlow Fish-bed: as in the British Museum Nos. 19821, 26045, 26046, 33216, 33322, I.151, &c.

3. Ceratiocaris valida, *T. R. J. and H. W.*, 1886, Pl. VI, figs. 10 and 11.

1866.	Ceratiocaris Murchisoni,		*H. Woodward.*	Geol. Mag., vol. iii, p. 205, pl. 10, figs. 8, 9.
1877.	—	—	—	Catal. Brit. Foss. Crust., p. 71.
1878.	—	—	(part), *H. N. & E.*	Catal. Camb. and Sil. Foss., M. P. G., p. 84.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., Brit. Assoc., p. 337; and Geol. Mag., 1885, p. 388.
1886.	—	valida,	—	Fourth Rep., Brit. Assoc., p. 230; Geol. Mag., 1886, p. 456.

The caudal appendages only are known; they are very stout, curved at first downwards and then upwards. The style (about 125 mm. long) is strongly ridged and fluted, and it is pitted along two lines, one on each side. The stylets are ridged and 90 (?) mm. long. The heads of style and stylets are wrinkled lengthwise. A fragment of the ultimate segment, attached, shows that it was ornamented with straight wrinkles. The specimens from the Wenlock-beds of Dudley and Kirkby Lonsdale, described and figured in the 'Geol. Mag.,' 1866, p. 204, pl. 10, figs. 8 and 9, as belonging to *C. Murchisoni*, are too thick and strong for that species, and the Dudley example (fig. 8) has different proportions. We propose to distinguish them as *C. valida*.

Pl. VI, figs. 10, 11. Copied from the 'Geological Magazine,' vol. iii, 1866, pl. 10, figs. 8, 9. Wenlock Shale, Dudley, collected by Mr. Hollier.

Fig. 10. 'Geol. Mag.,' vol. iii, p. 204, pl. 10, fig. 8, "*C. Murchisoni*," in Dr. H. Woodward's paper "On the Occurrence of *Ceratiocaris* in the Wenlock Formation (Upper Silurian) of England." Portion of a style (telson), attached to a small piece of an ultimate segment, and two stylets, one with a sharp perfect end, the other somewhat shortened. All are grooved and ridged, and the telson bears a row of strong puncta along one side of its outer ridge. The describer writes: "The specimen from Dudley has been partially worked out on the upper edge of the slab of shale on which it rests, so as to expose both sides of the central spine (telson); and, although much flattened, it exhibits another row of punctations corresponding to that seen in the plate, and two intermediate dorsal furrows."

Fig. 11. *Op. cit.*, fig. 9. (Mus. Pract. Geol. $\frac{17}{15}$.) 'Catal. Camb. and Sil. Fos.,' 1878, p. 84. From Casterton Low Fell, Kirkby Lonsdale, Westmoreland. The section of the strata of this hill, with the Barbon Low Fell adjacent, is figured and described by Prof. T. McKenny Hughes in the 'Geol. Mag.,' vol. iii, pp. 206—208. *Cardiola interrupta* is a prominent fossil in these beds, which are equivalent to the Denbighshire Grits of the Wenlock series. Portions of telson and two stylets, all ridged; the former pitted along the side of its outer ridge.

Fig. 12. *Op. cit.*, fig. 10. (British Museum.) The head of a telson from the Silurian strata of Bohemia, showing the arrangement of two parallel rows of pits on longitudinal ridges, one on each side of the back with a median dorsal ridge between them. This may probably have been the arrangement in the English specimens, figs. 10 and 11 (and others), before they were modified by pressure.

Mr. G. J. Williams, F.G.S., of Ffestiniog, has a good, though imperfect, specimen of the caudal spines, from the Wenlock Shale of Harp Hollow, near Welshpool.

C. VALIDA.—Carapace not known. *Ultimate segment.*—Striated longitudinally. *Caudal spines.*—Thick, flexuous, ridged and fluted. *Style.*—Punctate on each side of its dorsal ridge.

4. Ceratiocaris tyrannus, *Salter, MS.*, 1878. Pl. III, figs. 2, 3, 5, 6, 8; Pl. IV, fig. 4; Pl. V, fig. 4; Pl. IX, fig. 4 (?).

1878.	Ceratiocaris tyrannus, *Salter*, MS.,	*H. N. & E.*	Catal. Cambr. and Silur. Foss., M. P. G., p. 118.
1884.	—	Murchisoni, *La Touche.*	Handbook Geol. Shropshire, p. 37, pl. 17, fig. 565.
1885.	—	stygia (part),	*T. R. J. & H. W.* Third Report, Brit. Assoc., p. 345; Geol. Mag., 1885, p. 396.
1886.	—	attenuata,	— Fourth Rep., Brit. Assoc., p. 230; Geol. Mag., 1886, pp. 456, 457.

Some abdominal segments (Oxford Mus. E; Ludlow Mus. L; B. M. 39403; M. P. G. $\frac{2}{3}\frac{3}{5}$ and $\frac{2}{3}\frac{3}{6}$), narrow in proportion to those in one other specimen marked $\frac{2}{3}\frac{3}{6}$, and referred to *C. Murchisoni* (above, p. 17), and very much narrower and smaller than in *C. gigas*, we separated in 1886 as belonging to a new species called *C. attenuata*, but we find that it is the *C. tyrannus* of Salter. They have straight styles and stylets, much shorter than in either of the foregoing.

Carapace not known, unless Pl. III, fig. 8, showing a fragment occurring on the tablet marked $\frac{2}{3}\frac{3}{6}$, belongs to it; if so, it is longitudinally striate. Segments narrow, ornamented with longitudinal wrinkles, which curve up and down at the anterior edge. Epimeral borders strongly defined and bearing joint-marks, either for contiguous segments or for abdominal appendages (uropods). The ultimate segment cylindrical (like others), straight-wrinkled, long, and narrow. Caudal appendages straight, sharp, and rather short; ridged and furrowed; style pitted (Pl. V, fig. 4).

In a small specimen (Pl. III, fig. 6) the stylet is 20 mm. long.; and the style was probably twice as long.

(Pl. II, fig. 4, and Pl. V, fig. 6, have caudal appendages very similar to those in Pl. III, figs. 3, 5, 6, and Pl. V, fig. 4, and possibly should be referred to *C. tyrannus* rather than to *C. Halliana;* but, taken together with Pl. IV, figs. 5 and 6, their carapaces graduate to that in Pl. II, fig. 1.)

Pl. III, fig. 2. Some segments, and part of appendages, lying at right-angles, and broken. Three body-segments shown as hollow casts. A tubercle on the lower part of the anterior third of each segment is shown by an impression in the casts. Longitudinal, wavy, irregular striæ (impressions of wrinklets) mark the segments; curving and anastomosing at the anterior or proximal edge. Parts of three caudal spines are present. Mus. Pract. Geol. Marked "$\frac{2}{3}\frac{3}{6}$. Lower Ludlow; Church Hill, Leintwardine. *Ceratiocaris tyrannus*, Salter." See 'Catal. Camb. and Sil. Foss., M. P. G.,' 1878, p. 118. In olive-grey mudstone; slightly micaceous.

Pl. III, fig. 3. Four segments and crushed fragment of telson and a stylet, preserved as hollow casts, with traces of joints at the epimeral borders, as above. Mus. Pract. Geol. Marked "$\frac{2}{3}\frac{3}{6}$. *Ceratiocaris tyrannus*, Salter. Leintwardine." In olive-grey mudstone. See 'Catal.,' 1878, p. 118.

Pl. III, fig. 5. A small specimen of five body-segments, and caudal appendages crushed. There is a tubercle (joint-mark) in the lower front of the penultimate segment and the next above, and fainter in the other two. There is also a half-round joint in the posterior angle (indistinct) of the penultimate segment. The ultimate segment has straight striæ. There are also faint indications of a rounded posterior angle, and of an acetabulum on the telson, crushed up; that is, there is an obscure joint-like hollow on it to fit against the lower posterior angle of the ultimate segment. The telson-head has a minute leaf-like anastomosing ornamentation, not shown in fig. 5. Mus. Pract. Geol. Marked "$\frac{2}{3}\frac{3}{5}$. Wyatt-Edgell Collection. Lower Ludlow, Leintwardine. *Ceratiocaris tyrannus*, Salter." See 'Catal. Camb. and Sil. Foss.,' 1878, p. 118.

Pl. III, fig. 6. Four segments and appendages imperfect. The rounded head of telson is rather more distinct than in the figure; but no corresponding articular facet is left at the angle of the ultimate segment. Head of the stylet is apparently rounded, and more distinctly pressed into the lower angle of the ultimate segment than in the figure. Indication of a joint-socket at the lower posterior angle of penultimate segment (not in figure). Telson and stylet ridged longitudinally. The ultimate and penultimate segments show the inside of their tests. The next is a hollow cast of the outside of the shell; and the uppermost segment shows its outside.

B. M. 39403. Greenish-grey micaceous mudstone with impressions of *Discina* and other small shells (not Brachiopods), and impressions of fossil plant and Orthoceras? Lower Ludlow; Ludlow. A. Marston Coll.

Pl. III, fig. 8. This is part of a carapace-valve, longitudinally striate. Striæ very fine on the dorsal region, coarser along the middle, and coarsest along the ventral region. (On the back of this specimen is the smooth convex cast of a small right valve,[1] as small as Oxford Mus. J., Pl. IV, fig. 6, and with truncate posterior like that of Oxford Mus. K., fig. 5) Mus. Pract. Geol. Marked "$\frac{2}{3}\frac{3}{6}$. *C. tyrannus*, Salter. Leintwardine." See 'Catal.,' 1878, p. 118.

In brownish-grey micaceous mudstone, like other pieces of the same $\frac{2}{3}\frac{3}{6}$.

Pl. IV, fig. 4. Seven segments (convex casts with films of the test), broken-in along their upper thirds, and part of the other side shown by impressions above and beyond them. Tubercle (? joint) with hollow upper face, strong on the penultimate and the next segment, and faint on that preceding. Terminal portions of two of the caudal spines are present. The ultimate segment is pinched-up along

[1] An oblique fragment of shell imitates a tail in this little specimen.

its middle. Oxford Mus. E. "Lower Ludlow; Leintwardine." Brownish mudstone.

Pl. V, fig. 4. Four segments and two of the appendages. The four body-segments, with relics of the test, are ornamented with longitudinal and anastomosing wrinklets. The style and one stylet, imperfectly preserved, are both longitudinally ridged. The head of the telson (style), adherent at the joint to the ultimate segment, is lattice-marked; and the telson is dorsally pitted. The stylet, almost perfect, was probably about 20 mm. in length, and the style may have been about 40 mm.

In light grey mudstone; slightly calcareous. Lower Ludlow; Church Hill, Leintwardine. Marston Coll. Ludlow Museum, L. Figured in La Touche's 'Handbook of the Geology of Shropshire,' 1884, pl. 17, fig. 565.

Pl. IX, fig. 4. Imperfect segment. A portion of an abdominal segment showing the epimeral furrow and the longitudinal, inosculating, raised striæ or wrinklets, turning down at the lower corner of the anterior portion. The upper anterior corner is wanting. Magnified 4 diameters. This seems to agree with the small specimen of *C. tyrannus*, Pl. III, fig. 5. Compare also Pl. V, figs. 4 and 6 *b*; Pl. IV, fig. 4; and Pl. I, aa. Some of these are in reverse, as they belong to the other side of the abdomen. In Mr. Salwey's collection, Ludlow; on the back of the specimen with *Physocaris vesica* (Pl. VII, fig. 8); from Leintwardine.

In the Ludlow Museum the specimen marked M, from the Lower Ludlow-beds of Clunbury (?), has four segments of *C. tyrannus*, with appendages, all crushed. Also the specimen Q, from Church Hill, Leintwardine, Lightbody Coll., seems to belong to the same species, showing part of the last segment and appendages.

5. Ceratiocaris gigas, *Salter*, *MS.*, 1865. Pl. III, fig. 1; Pl. IV, fig. 2; Pl. V, fig. 5.

1865.	Ceratiocaris gigas (*Salter*),			*H. & E.*	Catal. Foss. M. P. G., p. 79.
1878.	—	—	—	*H. N. & E.*	Catal. Cambr. and Silur. Fossils, Mus. Pract. Geol., p. 141.
1885.	—	Murchisoni,		*T. R. J. & H. W.*	Third Report, Brit. Assoc., p. 338; Geol. Mag., 1885, p. 389.
1886.	—	gigas,		—	Fourth Rep., Brit. Assoc., pp. 229, 230; Geol. Mag., 1886, p. 456.

The caudal appendages of *C. Murchisoni* have a slight curvature; there are others much like them, but straight and associated with a large ultimate segment,

much broader than that in M. P. G. $\frac{2}{3}\frac{3}{6}$, Pl. III, figs. 2, 3. For instance, Oxford Mus. F; M. P. G. x $\frac{1}{2}$; Ludlow Mus. T. One of these (x $\frac{1}{2}$) has been labelled *C. gigas* by Mr. Salter, and therefore we adopt that name.

Only the ultimate segment and the three caudal spines are known. The former is large, being broad and strong, and is marked with longitudinal wrinkles; the latter are long, straight, and ridged. The style is strongly fluted and pitted, and its head bears the leaf- or lattice-pattern.

The characteristic fragment of this species, in the Museum Pract. Geology, marked x $\frac{1}{2}$, and labelled *C. gigas* by Mr. Salter, was entered in the 'Catalogue of Fossils,' 1865, under that name.

Pl. III, fig. 1. An ultimate segment, and upper portion of caudal appendages crushed. This segment has thin longitudinal wrinklets; and its terminal rim is regular for a part of its length. The head of the telson is bulbous, and below it the tops of the caudal spines are crushed. The telson is ridged. Mus. Pract. Geol. Marked "x $\frac{1}{2}$. Lower Ludlow; Danefield, Kington. *Ceratiocaris gigas?* Salter. Presented by J. W. Salter, Esq." See 'Catal.,' 1878, p. 141. Darkish olive-grey micaceous mudstone.

Pl. IV, fig. 2. Ultimate segment and caudal appendages. The head of a stylet is close to a semicircular acetabulum under the shoulder of the telson-head. Stylet, 55 mm. long; style probably twice as long.

Articulation between telson and lower angle of ultimate segment almost perfect. Under or inner flange at top of the telson well preserved (brown-black). Inosculating angular wrinkles on telson-head making minute leaf-marks.

Strong, raised, interrupted, inosculating, longitudinal wrinkles on the ultimate segment; also semicircular facet for the preceding segment. Oxford F. In greenish-grey mudstone, weathering brownish; calcareous at the edge, along very thin seams. Lower Ludlow.

Pl. V, fig. 5. An ultimate segment, like that of Pl. IV, fig. 2; but, though crushed, more perfect at its upper dorsal angle. The articulation for the preceding segment is well preserved. The longitudinal sculpture of anastomosing wrinklets is very distinct on this purplish specimen. Ludlow Museum T. In light greenish-grey micaceous mudstone, calcareous. Marked "Lower Ludlow; Church Hill. *C. gigas.* H. Pardoe."

Specimens corresponding in character with *C. gigas* are: 1. Ludlow Museum R, a broken ultimate and imperfect appendages, from Church Hill, Marston Coll. 2. Parts of a straight style and stylet; as a ferruginous cast. From the Upper Coldwell Beds (= Wenlock), South of Coldwell Quarry, Windermere. Cambridge Museum; Marr Collection.

Either *C. gigas* or *C. Murchisoni:* 1. Fragment of a straight, strong telson. Ludlow beds; Bury Ditches, Salop. British Museum. 2. Fragment of a caudal

spine, in hard micaceous mudstone with Orthides. Oxford Museum D. 3. A similar piece, from Church Hill, near Ludlow. In Mr. Cocking's Collection.

C. gigas is comparable with *C. Bohemica*, Barrande, 1853, 'N. Jahrb.,' and 'Sil. Syst. Bohème,' vol. i, Suppl., p. 447, pl. 19, figs. 1—13.

6. Ceratiocaris Halliana, *T. R. J. and H. W.*, 1886. Pl. II, figs. 1, 2, 3, 4 (?); Pl. IV, figs. 5, 6; Pl. V, figs. 6 *a*, 6 *b* (?).

1860.	Ceratiocaris leptodactylus, *Salter.*		Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 157.
1865.	—	—	*H. & E.* Catal. Foss., M. P. G., p. 79.
1878.	—	—	*H. N. & E.* Catal. Cambr. and Silur. Foss., Mus. Pract. Geol., pp. 118, 142.
1884.	—	—	*La Touche.* Handbook Geol. Shropshire, p. 37, pl. 17, fig. 566.
1885.	—	Murchisoni (part), *T. R. J. & H. W.*	Third Report Palæoz. Phyll., Brit. Assoc., pp. 337—340; Geol. Mag., 1885, p. 388.
1886.	—	Halliana, *T. R. J. & H. W.*	Fourth Report, p. 230; Geol. Mag., 1886, p. 457.

One fine large carapace (M. P. G. x $\frac{1}{5}$) and others smaller and less definite in some respects (M. P. G. x $\frac{1}{7}$; x $\frac{1}{6}$; x $\frac{1}{9}$; Ludlow Mus. A; Oxford Mus. K and J), and associated with segments and appendages, we regard as distinctive of a new species, though formerly referred to *C. leptodactylus* and *Murchisoni*, M'Coy. The test, though thin, appears to have been of an unusually hard consistency.

These carapaces in some instances have been much modified by pressure, but we trace a close similarity throughout the series, allowing for probable differences of age.

The carapace (large or small) is long and smooth; pyriform, or acutely sub-ovate, deep behind, narrow in front; gently convex on the back; outlined by a bold elliptical curve on the ventral margin, which rises up to form with the dorsal edge a sharp angle in front, above the median line of the valve; but this and other features varied with age and sex, and have been modified by pressure in the different specimens. The antero-ventral margin is sometimes in-drawn, making the point in front more acute. The hinder margin is truncate with an elegant ogee curve, full below, and ending above in the postero-dorsal angle, which is often but not always sharply defined in the specimens. In some cases the ventral margin is much deeper than in others.

Five to eight segments are exposed, usually with obscure straight striæ, but occasionally retaining a more complicated wrinkling at the anterior edge (Pl. V,

fig. 6 *b*). Telson and stylets delicately ridged; the former pitted, and its head obscurely wrinkled (Pl. II, fig. 4).

The shape of the carapace approximates to that of Dr. James Hall's species *C. acuminata* and F. Schmidt's *C. Noetlingi* ('Third Report, Brit. Assoc.,' p. 355). There are marked differences, however, and we have designated this form *C. Halliana*, in honour of our old and valued friend, who began working at these Phyllocarida as early as 1852.

A perfect specimen of *C. acuminata*, Hall, has been described and figured by Dr. Julius Pohlman in the 'Bulletin of the Buffalo Society of Natural Sciences,' vol. v, No. 1, 1886, pp. 28, 29, pl. 3, fig. 2. Its caudal appendages are much like those of *C. papilio* and *C. stygia*, the style being relatively short, and the stylets broad and blade-like. The appendages in M. P. G. x $\frac{1}{7}$, x $\frac{1}{9}$, and Ludlow Mus. A, are different from these, being thinner, tapering slowly, and pitted in at least one row, as seen exposed.

The specimens under notice are probably the same as those which Mr. Salter apportioned to *C. leptodactylus*—" Cephalothorax long, triangular, acute in front, broad and rounded behind. Free abdominal segments 7 to 8 in number, subquadrate, deeply impressed at the sides. Caudal appendages long, striate; the central spine (telson) scarcely thicker than the long lateral spines. Surface of carapace smooth, or marked with only very short sparse lines. Abdominal segments strongly striate. The whole animal elongate and more than a foot long." ('Annals Mag. Nat. Hist.,' ser. 3, vol. v, 1860, p. 157.) One particular specimen in the Mus. Pract. Geol. is referred to by Mr. Salter at p. 158 (perhaps Pl. II, fig. 2 or fig. 4). We are at a loss in fitting the indicated slender appendages of *C. leptodactylus* to the carapace above described. We have examined the above-mentioned and other good specimens, labelled *C. leptodactylus* by Mr. Salter, or at his direction, in which the *carapace* agrees with his description. One carapace is of large size, nearly perfect, about 125 mm. (5 inches) long, by 55 mm. at greatest height; M. P. G. x $\frac{1}{5}$, Pl. II, fig. 1. A specimen nearly perfect, M. P. G. x $\frac{1}{7}$, 60 mm. long by 28 mm., gives no certain indication of the length of its telson and its two stylets, for they are crushed off short (Pl. II, fig. 2). The abdomen exposed is about 50 mm. in length.

There is also a well-preserved *small* specimen, M. P. G. x $\frac{1}{9}$, with its carapace measuring only 25 mm. in length and 11 mm. in height, from the Lower Ludlow of Bow Bridge, Ludlow (Pl. II, fig. 4). This is labelled "*C. leptodactylus*," but belongs to the same species as the foregoing. Its caudal appendages are perfect, with the telson (25 mm.) about one third of the length of the whole animal; and they differ from M'Coy's *C. leptodactylus* in their proportions.

Pl. II, fig. 4 and Pl. V, fig. 6 may possibly belong to *C. tyrannus*, for their caudal appendages agree with some referred to that species (see p. 22). For con-

venience, however, we have kept together those having carapaces; especially as these appear to graduate in shape from the very small specimens Pl. IV, figs. 5 and 6, to the large one Pl. II, fig. 1.

Pl. II, fig. 1. Carapace showing the left valve. This large carapace is imperfectly preserved, but shows all its shape, except that the anterior angle has been broken off. The valves are very thin; a portion of the left valve is present; and the right valve is represented in part by an impression of its outside; and its remainder is covered by the compressed layer of matrix which lies between the two valves, and the broken edge of which is exposed along the middle of the specimen. The valves were apparently quite smooth, and are slightly crumpled by pressure; the portion preserved is traversed by fine cracks, along and athwart, causing it to break into more or less quadrangular pieces.

Mus. Pract. Geol., marked "x $\frac{1}{5}$. Lower Ludlow; Church Hill, Leintwardine. *Ceratiocaris leptodactylus*, M'Coy." See 'Catal. Cambr. and Silur. Fossils, M. P. G.,' 1878, p. 142. In olive-grey mudstone,[1] weathering brownish.

Pl. II, fig. 2. Carapace, five or six abdominal segments, and part of the caudal appendages. Right valve shown, smooth, glazy, very thin, crumpled into irregular longitudinal folds, and breaking into small angular pieces. The posterior edge has been misshapen by pressure on the internal body-segments. The exposed segments are much crushed, but six are recognisable; the four above the penultimate retain their lower edges (though broken); and traces of a longitudinal striation are present here and there in all. The attachment of the style (telson) is obscure; also the individuality of the style and stylets. The presence of the teeth is indicated by minute mamillary projections in the anterior third of the valve. The front angle of the valve has been damaged. In the matrix beyond it is an irregular row of little pits, which seem to be the casts of small, short, hollow, ring-like bodies, possibly the remnants of some part (antenna?) of the animal protruded from the valves; or they may be some bodies altogether distinct.

Mus. Pract. Geol., marked "x $\frac{1}{7}$. Lower Ludlow; Leintwardine. *Ceratiocaris leptodactylus*, M'Coy. Presented by A. Marston." See 'Catal. Cambr. and Sil. Foss.,' 1878, p. 142. In olive-grey, micaceous mudstone, weathering brown. Some casts of small Rhynchonella-like Brachiopods lie in the matrix.

This may be the specimen referred to by Mr. Salter in the 'Ann. Mag. Nat. Hist.,' March, 1860, p. 158.

Pl. II, fig. 3. Carapace and four or five segments. This specimen is chiefly an impression, but with some films of the test, showing a right valve, smooth (glazy), but wrinkled by pressure along the ventral margin. The maxillæ are indicated by their mark within the valves. Five abdominal segments, much crushed,

[1] Some of the mudstone, containing the specimen of *Ceratiocaris* from Ludlow, is calcareous, especially in very thin seams at the edges of the slabs.

are shown. The one next the valve is broken by a crack in the stone. Some others (five ?) have left a faint trace within the carapace.

Mus. Pract. Geol., marked "x $\frac{1}{6}$. Lower Ludlow; Leintwardine. *Ceratiocaris leptodactylus*, M'Coy." See 'Catal.,' 1878, p. 142. In olive-grey micaceous mudstone.

Pl. II, fig. 4. Carapace, five or six segments, and the caudal appendages. The carapace is small (25×12 mm.), and shows its left valve. The valve is smooth, but crumpled lengthwise, and wrinkled in the ventral region. The maxillæ are indicated by pressure in the anterior third. The abdominal segments are crushed, and, being defective in their upper and lower margins, therefore look narrower than they were originally. There are traces of longitudinal striation on all the segments. The style is 25 mm. long, minutely ridged, and rugose; this roughness being due probably to decomposition, but partly perhaps to having been originally tuberculate or spined. There are two stylets, much shorter than the telson, unequally preserved, and close together; one is about 12 mm. long.

Mus. Pract. Geol., marked "x $\frac{1}{9}$. Lower Ludlow; Bow Bridge, Ludlow. *Ceratiocaris leptodactylus*, M'Coy. Presented by A. Marston." See 'Catal.,' 1878, p. 142. In olive-grey micaceous sandstone, with small Brachiopods and Orthoceras.

Pl. IV, fig. 5. Small carapace and two segments. The former apparently smooth, but bearing obscure longitudinal striæ in the postero-dorsal region. Thickened with obscure internal contents. Segments passing up apparently to the anterior third (upper side). Young (?). Oxford Mus. K. Lower Ludlow. In brownish-grey mudstone.

Pl. IV, fig. 6. Very small carapace and six segments. Probably two valves, wrinkled by pressure; no striæ visible. Obscure organic contents. Six exposed segments shown as flat casts,—portions of the test on the last two longitudinally striate. Young (?). Oxford Mus. J. Lower Ludlow. Olive-grey mudstone.

Pl. V, figs. 6 *a*, 6 *b*. Carapace, eight segments, and caudal appendages. Carapace, with its right valve outwards, smooth, crushed, and somewhat crumpled along the ventral region. Anterior extremity frayed out. Indications of internal organs in the front part. Eight body-segments crushed and broken; one of them (sixth from the end) has the epimeral border preserved with its neat sculpturing, partly longitudinal, and partly interlacing or lattice-like (fig. 6 *b*). Articulations (for uropods ?) are present on the lower portions of some segments. Telson and stylets imperfectly preserved; the former pitted with prickle-bases. Some small scattered dark spots occur on the stone beneath the anterior end of the carapace, and these may have been fragments of some of the internal organs.

In hard greenish-grey mudstone, with small Brachiopods; calcareous. Lower

Ludlow. Ludlow Museum A, marked "*C. leptodactylus*, Marston Coll." This is figured in La Touche's 'Handbook Geol. Shropshire,' 1884, pl. 17, fig. 566.

C. Halliana.—*Carapace.*—Long, sub-triangular, pyriform.
Body-segments.—With straight striæ.
Caudal appendages.—Delicately ridged; *style* pitted.

7. Ceratiocaris Pardoëana, *La Touche*, 1884. Pl. V, figs. 1 and 2.

1884. Ceratiocaris Pardoensis (part), *La Touche.* Handbook to the Geology of Shropshire, p. 77, pl. 17, fig. 563.
1885. Ceratiocaris Murchisoni (part), *T. R. J. & H. W.* Third Report, Pal. Phyll., p. 337; Geol. Mag., 1885, p. 388.
1886. — Pardoëana, *T. R. J. & H. W.* Fourth Report, p. 230; Geol. Mag., 1886, p. 457.

Two carapaces with segments and parts of appendages from Ludlow (Ludlow Mus. B and D) differ from any other form. One of them (B), with a wrong caudal appendage (Pl. V, fig. 3, p. 19) attached to it, in the Ludlow Museum, has been labelled "*C. Pardoensis*," and as such is referred to in the Rev. J. D. La Touche's 'Handbook to the Geology of Shropshire.' We retain this name (altering the termination, as it refers to a person, and not a place) for the two carapaces here referred to. One of them (B) is of special interest as having its *rostrum* nearly in place (Pl. V, fig. 1).

In specimen D of the Ludlow Museum (Pl. V, fig. 2), which has the proximal portion only of the caudal spines preserved, and in specimen B, with the appendages also broken off short, the telson was ribbed and pitted (= prickly).

Carapace subovate, broad, and short; smooth (?), pitted (fringed) on ventral rim; pointed medially in front; truncate with ogee curve behind. Rostrum present in Pl. V, fig. 1. Segments, six, exposed. Ultimate segment long; all delicately wrinkled longitudinally. Style and stylets ridged; the former pitted.

Pl. V, fig. 1. Carapace, five or six abdominal segments, and part of the caudal spines. The right valve lies outwards, showing part of the moulded matrix between the valves and some relics of indistinguishable body-substance. Four segments preserve their shape (compressed) and test; and are continued inwards with indications of three others within the carapace. The intestinal tube is traceable from the posterior margin of the carapace to the lower angle of the ultimate segment. Longitudinal, sinuous, anastomosing wrinklets ornament the

surface of the segments. The proximal portion of the crushed caudal appendages is present; the telson is punctate with the bases of prickles along its dorsal edge.

In a green-grey, rather hard mudstone; calcareous throughout, but less in some parts than in others. Lower Ludlow; Church Hill, Leintwardine. Ludlow Museum B. Pardoe Coll.

Pl. V, fig. 2. Carapace, five or six segments, and part of the caudal appendages. A smooth, but crumpled carapace (left valve outwards), with obscure indications of internal organs, and a faint trace of an antenna (?) at its front apex. Five body-segments, partly crushed, some showing longitudinally wrinkled and anastomosing sculpture. Proximal portion of the style and two stylets is present; the style bearing a row of little pits (closer and rather more numerous than in the figure).

In greenish-grey micaceous mudstone, calcareous on the edge, weathering brownish, and bearing some impressions of small Brachiopods, with numerous spots and patches of organic origin. Lower Ludlow. Ludlow Museum D. Lightbody Coll.

C. Pardoëana.—*Carapace.*—Subovate, pointed in front, with *rostrum.*
Body-segments.—Delicately striate longitudinally.
Caudal appendages.—Strong, ridged; the *style* pitted dorsally.

8. Ceratiocaris canaliculata, *T. R. J. and H. W.*, 1886. Pl. IX, figs. 2 and 3.

1886. Ceratiocaris canaliculata, *T. R. J. & H. W.* Fourth Report on the Palæozoic Phyllopoda, Brit. Assoc., p. 230; and Geol. Mag., October, 1886, p. 457.

Two small specimens showing crushed telsons (one in Mr. Cocking's collection, and the other M. P. G. x $\frac{1}{2\,8}$; both from the Ludlow series). These are rather stout and ridged, and have a fluted or channelled sculpture on their upper part, instead of either wrinkles or leaf-pattern; hence we have given the name *canaliculata.* The ultimate segment bears straight striæ (fig. 3).

Pl. IX, fig. 2. The upper portion of a much crushed and broken telson, reddish-brown, ridged, and bearing straight, low, rather broad wrinkles at its proximal end, and indications of the bases of bristles (pits) on its outer edge (displaced by crushing).

In rather soft, light-greenish grey, micaceous, and calcareous mudstone. Upper Ludlow Beds; Whitcliffe, Ludlow. Mr. Cocking's Collection.

Pl. IX, fig. 3. Part of an ultimate segment and caudal appendage (telson) crushed and imperfect. The former shows strong, sharp, longitudinal, inosculating wrinklets; the latter, consisting of a broken telson, ridged and furrowed, shows at its articular or proximal end nearly straight, feeble, but rather wide wrinkles running down into the ridges, as in fig. 2.

In the Museum of Practical Geology, marked x $\frac{1}{28}$. Grey mudstone, brownish on one face, greenish elsewhere, finely micaceous, and partially calcareous; with casts of Polyzoa, small Brachiopoda, &c. Upper Ludlow Beds; Whitcliffe, Ludlow (old wall). Collected by Mr. Lightbody.

9. Ceratiocaris Ludensis, *H. Woodward*, 1871. Pl. I, and Pl. IX, figs. 1 *a*, 1 *b*.

1871.	Ceratiocaris Ludensis, *H. Woodward.*		Geol. Mag., vol. viii, p. 104, pl. 3, fig. 3.
1884.	—	—	*Jones and Woodward.* Geol. Mag., dec. 3, vol. i, p. 396.
1885.	—	—	*T. R. J. & H. W.* Third Report Palæoz. Phyll., Brit. Assoc., p. 341; Geol. Mag., dec. 3, vol. ii, No. 9, September, 1885, p 392.
1886.	—	—	*T. R. J. & H. W.* Fourth Report, p. 230; Geol. Mag., dec. 3, vol. iii, p. 457.

This large and indeed gigantic *Ceratiocaris*, represented by seven abdominal segments, with the caudal appendages of telson and two stylets, in the Ludlow Museum, was described in the 'Geol. Mag.' for March, 1871, and illustrated with a reduced figure. The carapace is there estimated as having probably been eight inches in length. The segments giving eight inches, and the telson having been probably more than nine inches in length (possibly much more, see p. 34), the animal was more than two feet in total length. As pointed out in the paper referred to, the telson, as estimated, is certainly the longest known; for we find the relative proportions to be—for *C. Ludensis*, H. W., 144; *C. Murchisoni* (Agass.), 128 (as defined above); *C. Dewcii* (J. Hall), 100; *C. Bohemica*, Barr. (Brit. Mus.), 84; *C. stygia*, Salter, 32; *C. Nætlingi*, F. Schmidt, 26; *C. papilio*, Salter, 16.

The segments are ornamented along the back with imbricated or lattice-like raised angular lines, which pass downwards on the sides into oblique and then curved wavy lines, and these form an irregular reticulation at the anterior margin. The ultimate segment was cylindrical, and is striated longitudinally with interrupted and inosculating lines. The caudal spines are stout, tapering slowly, slightly curved inwards (downwards), and delicately ribbed; and one bears some marks of the bases of setæ or prickles (F, in Pl. IX, fig. 1 *a*).

This fine specimen is from the laminated mudstone of the Lower-Ludlow series, at Church Hill, Leintwardine, near Ludlow, associated with Graptolites. It was obtained many years since by the late Mr. H. Pardoe, and is preserved in the Ludlow Museum.

On careful examination of this large specimen of *C. Ludensis*, H. W., we have reason to believe that the caudal appendage which appears longest in the fossil was not really the longest, or the true telson, but was one of the "laterals" or stylets. Hence the whole animal was probably much longer than our first estimate made it.

Pl. I. *Ceratiocaris Ludensis*, H. W. (Ludlow Museum.) Two thirds of the natural size. (See also a portion, in Pl. IX, of the natural size.) Leintwardine. Greenish-grey, hard, micaceous, calcareous mudstone, with many small Graptolites (*Monograptus priodon*), nearly all lying in one direction. There are also other little marks of organic origin, and a few obscure impressions of larger fossils.

Seven abdominal segments (A and B) and three caudal appendages (C—G). The former are laterally compressed; the latter much damaged by breakage of the stone. Six segments (A) have an ornament of raised wrinklets, longitudinal and inosculating, but turning up and down on the anterior third. The seventh, or ultimate segment (B), has only longitudinal wrinklets, interrupted and inosculating. The opposite sides of five segments, A, are figured at AA, showing their epimera; and the opposite sides of the penultimate (part of A) and the ultimate (B) segments, taken out from their embedment (being loose), are shown at BB.

At C (in intaglio) and CC (in relief) is seen the distal end of what appears (at first sight) to have been the longest of the caudal spines, smooth and depressed for the distance of half an inch from the end; then bearing three ridges, besides the half-buried thick edges; and at first slightly, and then strongly marked by successive constrictions across the ridges, so as to present a series of several, nearly equal, ridged tubercles, set more or less obliquely across the spine. These bear no definite marks of pitting. See Pl. IX, fig. 1 *b*, for an enlarged view of this piece.

In the next portion upward (D) of this caudal spine the outside has quite gone, and the internal structure is obscure. A small piece of what appears to be a smooth, ridged, caudal spine appears (not seen in Pl. I) in the stone near this part, at a higher level, and almost in a line with another caudal spine (F). What remains of the upper or proximal end (E) of the caudal spine C, D, is partly convex, and roundly truncate, ending apparently with such a joint as the stylets or lateral caudal spines have at the top. Downwards it has been squeezed flat, showing obscure lumpy ridges and confused internal structure. For about an inch before it is concealed by the matrix (D) it is modified by another fossil (fragment of *Eurypterus ?*) having lain across it.

This caudal spine (C, D, E) seems, from the apposition of its rounded top to

the hollow or socket of an articulation in the larger caudal spine lying closely above it, to have been a lateral or stylet. If so, its length ($7\frac{3}{4}$ inches, though imperfect) indicates a very great size for the whole animal, since the median or chief caudal spine (style or telson) must have been much longer. Its relative position at present can be accounted for by supposing it to have been pressed obliquely outwards, so as to have been displaced backward.

At F a piece of a caudal spine is seen separate from, and at a different level from that of E, but showing obscurely the same kind of lumpy surface as at C, C; and higher up with a few obscure, minute, oval areoles with central pimples, or prominences for the attachment of prickles.

At G is the badly preserved upper end ($1\frac{3}{8}$ inch) of a caudal spine (probably the telson or style) distinct from and at a different level to the others (E and F). It is broader than either of the other two. Its proximal end widens out ($\frac{1}{2}$ inch) before it is damaged and broken through, and thereby divided from what may be its top portion, which is in apposition (with a joint) to the ultimate segment. It retains (below the fracture) the curved socket for one of the laterals or stylets.

Unfortunately, nothing of the other extremity of this large spine (G) is to be seen in the further part of the stone.

Pl. IX, figs. 1 *a*, 1 *b*. *Ceratiocaris Ludensis*, H. W., as in Pl. I, but not reduced.

Fig. 1 *a*. The impression of the penultimate and ultimate segments in the matrix, and the caudal appendages, all of the natural size. The former show the impressions of the raised wrinklets on the matrix, and some portions of the inside of the test with its sunken striæ, or backs of the wrinklets; also the articulation (somewhat crushed) of the head of the telson, and below, broken off, the remnants of the three large caudal spines, figured two thirds natural size in Pl. I, and described at p. 33. The outer (right hand) seems, at first glance, to be the style, but very possibly the inner one (on left hand), though not in its natural position, may have been really the large, median spine or telson. The articulation above probably belonged to it; especially as a socket under its shoulder seems to be fitted by the head of the outer spine. This latter, and the more obscure third spine, may well have been the lateral spines thrown out of position by pressure.

Under these circumstances the length of the main caudal appendage (telson or style) cannot be ascertained, and it may have been at least more than half as long again as the lateral spine, which measures $7\frac{3}{4}$ inches.

Fig. 1 *b*. The lower portion of the spine marked C, enlarged twice. (See also Pl. I, C.)

10. CERATIOCARIS PAPILIO,[1] *Salter*, 1860. Pl. XI, figs. 4 *a*, 4 *b*, 6; Pl. XII, fig. 1.

1859.	CERATIOCARIS, *Salter.*		In Murchison's Siluria, 2nd (3rd) edit., p. 262, woodcut, fig. 1, p. 538.
1860.	—	PAPILIO, *Salter.*	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 154, woodcut, fig. 1, and p. 155.
1865.	—	—	*Salter and H. Woodward.* Catal. and Chart Foss. Crust., p. 17 (not fig. 5).
1865.	—	—	*H. Woodward.* Geol. Mag., vol. ii, p. 403, pl. 11, figs. 1 and 2.
1865.	—	—	*H. & E.* Catal. Foss. M. P. G., p. 79.
1867.	—	—	*Salter.* In Siluria, 3rd (4th) edit., p. 236, woodcut, fig. 1 (not fig. 2), and p. 516.
1873.	—	—	— Catal. Camb. and Sil. Woodw. Foss., p. 178.
1873.	—	—	*R. Etheridge, jun.* Mem. Geol. Surv. Scotl. Expl. Map 23, pp. 55, 56.
1876.	—	—	*Armstrong and others.* Catal. W.-Scot. Fossils, p. 24.
1877.	—	—	*H. Woodward.* Catal. Brit. Foss. Crust., p. 71.
1878.	—	—	*Huxley, Newton, and Etheridge.* Catal. Camb. and Sil. Foss., p. 142.
1885.	—	—	*T. R. J. & H. W.* Third Report Pal. Phyll., p. 341; Geol. Mag., 1885, p. 392, pl. 10, fig. 1.
1886.	—	—	— Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

We have not yet by any means exhausted the study of *C. papilio* and *stygia*. We know, however, that the abdominal segments in both were delicately sculptured with leaf-like or lattice-pattern ornament, as in some other species, the points of the triangles pointing upwards, or rather backwards, towards the carapace, and one limb of the triangle, where free, running downwards and outwards in the other direction. These oblique lines are often visible when the triangles have disappeared from wear or decomposition. Among many others the segments M. P. G. $\times \frac{1}{17}$; B. M. 41900: Oxford Mus. A and H exhibit fine examples of this leaf-like ornament; and it is visible in several more complete individuals in those collections. In the Braidwood, Glasgow, and Edinburgh Museums numerous specimens (chiefly *C. stygia*) show it well.

Of the two species, so abundant in the Lower Ludlow Shales of Logan

[1] Of this species and *C. stygia* we have more material at our command than we have been as yet able to figure and fully describe. We rest content at present with Pl. XII and the few other figures, intending to give illustrations and detailed descriptions of other and better specimens further on.

Water, near Lesmahago, in Lanarkshire, and described (unfortunately without good figures) by J. W. Salter in the 'Ann. and Mag. Nat. Hist.' for March, 1860, we have examined many good specimens. As mentioned by Salter, one (*C. papilio*) has the carapace more oblong than the other (*C. stygia*), which is deepened by a greater or less angularity on its ventral margin. In the woodcut diagrams at p. 154 of his memoir, fig. 1 is the oblong form, and figs. 2 and 3 have the deep ventral angle (*C. stygia*), and yet they are all three termed *C. papilio*, evidently from oversight. In the Lesmahago district multitudes of the two species seem to have been embedded in the black mud (now shales); and frequent references to these interesting deposits are made in 'Siluria,' 'Memoirs of the Geological Survey of Scotland' (especially 'Explanation of Map 23,' p. 49, &c.), in other works on Scottish geology, in geological manuals, &c., and in Dr. J. R. S. Hunter's papers in the 'Trans. Geol. Soc. Glasgow,' vol. vii, pp. 56, 272, &c.

In *C. papilio* the carapace is sub-oblong, straight on the back, gently curved below, like the prow of a boat in front, and truncate with an ogee curve behind. The anterior extremity is rather sharp and is rarely preserved; it slopes with a gentle curve downwards and backwards from the antero-dorsal angle to the ventral margin. The latter is somewhat convex in outline, with its greatest fulness rather forward, but near the middle; varying, however, with every specimen, all being more or less squeezed out of their true shape. The front moiety usually keeps its shape more truly than the posterior region, of which sometimes the dorsal angle (as in Brit. Mus. 41896, 41897), and sometimes the boldly-curved ventral portion (as in Brit. Mus. 41894, 58669; Cambridge Mus. *b*/135; and M. P. G. x $\frac{1}{1\,5}$), becomes the more prominent. The surface of the valves is delicately striate, with longitudinal lines, curving parallel with the ventral margin, and coarser below than near the back. In some specimens the lines are seen to converge at (or rather, as it were, to start from) the postero-dorsal angles. The ventral margin is rimmed, and often beset with the bases of former setæ. The body-segments are leaf-marked and obliquely striated. The telson (style), relatively stout, and not much longer than the laterals or stylets, is faintly ridged, and was perhaps prickly or spinose. The whole adult animal was probably from four to six inches long.

Having seen but few specimens in which the caudal appendages are well preserved in their place, we get but few good measurements.

Mr. Salter says that only three or four of the abdominal segments were free (external to the carapace); but probably there were even five; for in one specimen (Brit. Mus. 58669; Pl. XII, fig. 1) five segments of large size, now loose and reversed, were probably exposed beyond the carapace; and in another (Brit. Mus. 41895) four, with an imperfect fifth, have been shifted out of place. The segments, excepting the last one, appear in their compressed condition to be half as long as high, and the last one as long as three of the others.

In Brit. Mus. 41894, the carapace is 60 mm. long by 30 mm. deep (or high), and probably once rather deeper, having suffered from pressure. The penultimate segment is 10 mm. long, and if there were four of that length (40 mm.), with the ultimate segment (unusually long) the body-rings would be nearly 80 mm. The telson was 25 mm. (stylets 18 mm.). Thus, altogether, the animal was about 152 mm., or six inches, in length.

Brit. Mus. 58669 (Pl. XII, fig. 1) has a longer (narrowed) carapace, five body-rings, and a broken telson; altogether, six and a quarter inches long.

In another, but smaller individual (Brit. Mus. 41895), the carapace 40×20? mm.; segments 40 mm., but shortened; and style about 20 mm. (stylets 15 mm. each), make about 100 mm., or four inches, of total length.

A specimen at Glasgow has the carapace 50 mm. long, five segments 35 mm., and the style about 25 mm. At Braidwood there is a specimen with the carapace 83 mm. long. Of twelve good specimens from Lesmahago we have seen two consisting of carapace only; and in all the others the body-portion is more or less shifted, and in seven of them it is quite reversed—that is, lying at the anterior instead of the posterior end, as described by Mr. Salter ('Ann. Mag. Nat. Hist.,' ser. 3, vol. v, 1860, p. 154; and 'Siluria,' 1867, p. 236, &c.).

The specimen Cambridge Museum *b*/36 (from Benson Knot; "*C. inornatus*, M'Coy," Salter's 'Catal. Camb. and Sil. Foss. Woodw. Coll.,' 1873, p. 178) is the penultimate and ultimate segments, with style and stylet, not crushed, but well preserved in shape, although without ornament (Pl. XI, fig. 1), of either *C. papilio* or *C. stygia*, judging from its proportions.

Of *C. papilio*, good specimens from Lesmahago:[1]

Cambridge Mus. *b*/135, with the rostrum lying at an angle across the anterior extremity. M. P. G. x $\frac{1}{15}$, x $\frac{1}{22}$. Brit. Mus. 41894, 41895, 41896, 41897, 45161, 47989, 58669. Also one in the Museum of the University of Glasgow, and one at least in the Braidwood Museum (from Shanks Castle; Dr. J. R. S. Hunter).

We have seen also some fossil carapaces from Benson Knot, Kendal (Upper Ludlow), which agree perfectly in form and proportions with *C. papilio* from Lesmahago, also in ornament, except that the postero-dorsal convergence of the striæ is not present. These are some of those marked 44342 in the British Museum; M. P. G. x $\frac{1}{4}$ ('Catal.,' 1878, p. 141). They range from 65 mm. long and 32 mm. high to 75×40 mm. Also a large imperfect specimen and some fragments in brown shale from Linburn, near Muirkirk (Brit. Mus., all marked 58878).

Moreover, the specimen N in the Ludlow Museum has the proportions and appearance of *C. papilio*, as far as it is preserved (wanting the antero-dorsal angle), from Church Hill, Leintwardine.

[1] For an account of the Geology of Lesmahago, see H. Woodward's 'Monograph of the Merostomata,' Pal. Soc., 1866, pp. 46—53.

Pl. XII, fig. 1. British Museum, No. 58669. In the black Upper Silurian shale of Lesmahago, Lanarkshire (Slimon Collection).

Two valves, delicately striate; shifted and squeezed; the right valve uppermost. With five body-segments at the anterior, instead of the posterior end. Style and stylets broken and displaced.

B. M. 41900 (Pl. XI, fig. 6) and 41901 (counterpart), Lesmahago. Three abdominal segments, lattice-marked and obliquely striate, and an ultimate segment with both oblique and straight striæ, probably due to two layers of the test. Telson, 30 mm. long; and two ensiform stylets, each about 13 mm. long. Pressed flat in slightly calcareous black shale.

Also Oxford Mus. H. (Pl. XI, figs. 4 *a*, 4 *b*) with four segments, style 30 mm., and stylet 15 mm., pressed sideways, in olive-grey shale; Ludlow (?).

It is possible that *C. papilio* may have been the *male*, and *C. stygia* the *female* of the one species.

11. Ceratiocaris stygia, *Salter*, 1860. Pl. X, figs. 7 *a* and *b*; Pl. XI, figs. 1, 3, and 7; Pl. XII, figs. 2 *a*, 2 *b*.

1859.	Ceratiocaris, *Salter.*	In Murchison's Siluria, 2nd (3rd) ed., p. 262, woodcut fig. 2.
1860.	—	stygius, *Salter.* Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 154, woodcut figs. 2, 3 (fig. 1 is *C. papilio*).
1865.	—	— *H. & E.* Catal. Foss. M. P. G., p. 79.
1865.	—	papilio, *Salter and Woodward.* Cat. and Chart Foss. Crust., p. 17, fig. 5.
1867.	—	stygius, *Salter.* In Siluria, 3rd (4th) ed., p. 236, woodcut fig. 2, and p. 517.
1873.	—	— — Cat. Camb. and Sil. Woodw. Foss., p. 178.
1873.	—	— *R. Etheridge, jun.* Mem. Geol. Surv. Scotl. Expl. Map 23, pp. 55, 56.
1876.	—	papilio, *F. Roem.* Leth. geogn., Th. i, Leth. Pal., pl. 19, fig. 4.
1876.	—	stygius, *Armstrong and others.* Cat. W.-Scot. Fossils, p. 24.
1877.	—	— *H. Woodward.* Catal. Brit. Foss. Crust., p. 73.
1878.	—	— *Huxley, Newton, and Etheridge.* Cat. Camb. Sil. Fossils, p. 142.
1885.	—	— *T. R. J. & H. W.* Third Report Pal. Phyll., p. 343; Geol. Mag., 1885, p. 394, pl. 10, figs. 2 *a*, *b*, *c*.
1886.	—	— *T. R. J. & H. W.* Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

Carapace-valves trapezoidal; back straight, but curving down for a short distance to the mucronate dorsal angle of the anterior edge, which then slopes, with a slight convexity and at a sharp angle, downwards and backwards, to about the middle of the ventral margin, where the valve is deepest (highest); the other half of the ventral edge rises slowly with a straight or nearly straight oblique edge to the blunt postero-ventral corner, whence the truncate hind margin rises, with a gentle concave curve, to the sharp postero-dorsal angle. When the valves are spread open a triangular space is left between the antero-dorsal angles. This condition and the shape are well shown in the outspread specimen M. P. G. x $\frac{1}{13}$. Fig. 2 *a* is taken from a less trapezoidal specimen. The outline is often modified by pressure in other positions, but not to quite so great an extent, as the shape of *C. papilio* is altered by squeeze in some instances. The valves are delicately striate, with longitudinal lines curving parallel with the ventral edge, and crowded at the postero-dorsal angles. The lower margin has a slightly thickened rim and is often marked with the bases of former setæ. The body-segments, of which probably five were outside the carapace (though often the segments seem to have been pushed back within the carapace after death), are marked with delicate, raised, oblique wrinkly lines on the sides, and ornamented on the back with a leaf-like pattern, or lattice-work, formed by an imbrication of angular lines, which pass down into the lateral oblique wrinkles. These joints are sometimes more than twice as high as long. The last one is usually as long as three of the others. The telson is apparently in some cases about half as long again as the stylets (as fifty is to thirty); and some specimens show traces of thin costulæ, and perhaps of prickles. The whole adult animals were from four to eight inches long.

In both *C. papilio* and *C. stygia* the caudal spines are broad and taper quickly; but the stylets are broader and shorter than the style. In *C. stygia* the style is usually rather more than twice, and in *C. papilio* only about twice as long as the ultimate segment.

Specimen M. P. G. x $\frac{1}{20}$ has the rostrum and maxillæ squeezed out loose near the front end of the carapace. A large individual, Cambridge Mus. *b*/65, measures—

Carapace	83 × 55 mm.		198 mm., or nearly 8 inches.
Four segments . .	40	65 mm.	
Last segment . . .	25		
Telson	50 „		

A small specimen, M. P. G. x $\frac{1}{13}$, measures—

Carapace	40 × 26 mm.		About 100 mm., or nearly 4 inches.
Four segments . .	20	30 mm ?	
Last segment . . .	10 ?		
Telson	30 „		

C. stygia was rather larger than *C. papilio;* its telson was larger; the carapace is markedly distinct by its trapezoidal outline, deep ventral region, and mucronate antero-dorsal angle, which was not nearly so often lost in fossilization as the front angle of *C. papilio.* In its rostrum, maxillæ, superficial ornament of carapace and of body-rings, it seems to have closely resembled *C. papilio.* In twenty-two good specimens from Lesmahago, two are simply carapaces; seven have body-segments in place and thirteen have them shifted or reversed. In this respect *C. stygia* seems to have been scarcely less liable to the dissolution of the membranous attachments of the body than its associate *C. papilio.*

A postero-dorsal fragment in Cambridge Museum (Marr Coll.), from the Denbighshire series (Wenlock), at Dinasbran, Llangollen, showing fine striæ above and coarse striæ below, and the usual convergence of striæ, belongs probably to *C. stygia.*

An anterior moiety of a valve, probably of *C. stygia* (from near Ludlow ?) is in the Grindrod Coll., Oxford Mus. G.

Good specimens of *C. stygia* from Lesmahago are Cambridge Mus. *b*/136, *b*/65 (the last is referred to as *C. papilio*, evidently by mistake, in the 'Catal. of the Cambrian and Silur. Fossils of the Woodw. Coll.,' 1873, p. 178); M. P. G. x $\frac{1}{13}$, $\frac{1}{14}$, x $\frac{1}{16}$, x $\frac{1}{19}$, x $\frac{1}{20}$, x $\frac{1}{21}$; and B. M. 41898, 45154, 45155, 45156.

In the 'Mem. Geol. Surv. Scotl. Expl. Map 23,' 1873, at p. 49, Mr. R. Etheridge, junr., enumerates the places near Lesmahago and Muirkirk, in Lanarkshire, where *Ceratiocarides* have been found by the Surveyors, namely—

Ceratiocaris papilio, Salter, at Dunside (Logan Water), Eaglinside Burn, Logan Water (2 miles south of Lesmahago), and Linburn.

Ceratiocaris stygia, Salter, at Kip Burn (Logan Water), Eaglinside Burn, and Linburn.

Ceratiocaris, caudal appendages, at Long Burn (Logan Water), Dunside (Logan Water), Logan Water (6 miles south-west of Lesmahago), Lann Burn, and Douglas Water.

There are some fine specimens of *C. stygia* in the Glasgow University Museum and the Geological Survey Museum, Edinburgh, from Lesmahago; very many in the Braidwood Museum (Dr. J. R. S. Hunter); and a few also in the Edinburgh University Museum, all from the same district. We have not yet been able to have a selection from these figured for the Palæontographical Society, but we hope to do justice to them before long and to some possibly new species associated with them.

Abdominal segments and appendages probably belonging to *C. stygia* are:

B. M. 58878, Linburn, Muirkirk. A telson, not quite perfect at base, 35 mm. long, associated with some obliquely-striate segments.

B. M. 41899, Lesmahago. Four segments, 27 mm., and M. P. G x $\frac{1}{25}c$,

four segments, 30 mm., and in each case two short ensiform stylets attached (style wanting).

Pl. XI, fig. 3. Mus. Pract. Geol., x $\frac{1}{1\,7}$, 1 ('Catal. Camb. Sil. Foss.,' 1878, p. 142, *C. robustus*). Lower Ludlow; Leintwardine. In hard olive-green shale, finely micaceous, not calcareous.

This seems to belong to *C. stygia*. It shows two segments and appendages, pressed sideways. Style, 50 mm.; one stylet present, broad and ensiform, 23 mm. long. The lattice-pattern ornaments the segments and head of the telson, which latter is much crushed.

M. P. G. x $\frac{1}{2\,5}a$, $\frac{1}{2\,5}b$, $\frac{1}{2\,5}d$, Logan Water, Lesmahago. Segments with oblique striæ (one ultimate segment has straight striæ), not well preserved. Probably *C. stygia*, as named in the 'Catal.,' 1878, p. 142.

Pl. X, fig. 7 (Cambridge Mus. *b*/35). An internal cast of a convex valve, retaining a very thin film of the test. The antero-dorsal angle has been damaged. This valve, in "Ludlow" rock (grey, micaceous, partly calcareous sandstone) from Benson Knot, Kendal, belongs probably to *C. stygia*,[1] or a variety of that species, if it be not a male individual, having (like Pl. XII, fig. 2) less ventral depth than usual among the many specimens from Lesmahago. The surface has parallel, longitudinal striæ; very delicate in the dorsal region, coarser below the middle, where they curve with the ventral margin, and here and there some die away.

Cambridge Mus. *b*/6 is a large hollow cast of a similar valve, imperfect. Upper layer of the stone with the cast not calcareous; lower part calcareous.

Pl. XI, fig. 1 (Cambr. Mus. *b*/36) is a caudal extremity, found also at Benson Knot, which would apparently suit such valves as Pl. X, fig. 7, and is not distinct from *C. stygia*, except that the telson has a *bulbous* or *rounded head*. As this is probably a specific character, we must not refer the associated valves (Pl. X, fig. 7) to *C. stygia* without some doubt. It is possible, however, that the latter species may have had such a telson-head, but that pressure and decomposition have generally destroyed all trace of it in the fossils.

A fine large specimen of this narrow variety of *C. stygia* (?), with a round-headed telson, is in the Museum of the Geological Survey of Scotland (M. 447), Edinburgh, from Eaglinside Burn, River Nethan, 4½ miles south-west of Lesmahago.

The specimen A, Oxford Museum (Grindrod Collection), Pl. XI, fig. 7, consists of the penultimate (11 mm.), and ultimate (20 mm.) segments, both finely lattice-marked, together with a broad style (45) and corresponding stylet (22 mm.), of what seems to be too large for *C. robusta*, but not long enough for *C. longa*. These caudal spines are strong, broad, and ensiform, the style is fluted; the stylet flat, except its marginal rims. The two segments are neatly ornamented with

[1] 'Fourth Report Foss. Phyll.,' 1886, p. 232, and 'Geol. Mag.,' 1886, p. 459.

imbricate lozenge-shaped, or sharp leaf-like lines, each angle inclosing a smaller leaf-like lattice-work, as in Barrande's *C. Scharyi*: all are pressed sideways. This is in the Lower-Ludlow mud-stone, olive-grey, laminated, and micaceous, associated with the remains of an Orthoceras. It may possibly belong to either *C. papilio* or *C. stygia*, if not to *C. longa*; but the telson appears to have been longer than that of *C. papilio*, and *round-headed*. This feature, which we observe also in a few Scotch specimens, and in Pl. XI, fig. 1, may be a specific distinction.

In the above-mentioned specimen (Cambridge Mus., *b*/36, Pl. XI, fig. 1) of two abdominal segments, with a style and a stylet in good preservation, convex and not injured by pressure, the penultimate segment is smooth, but shows some traces of oblique lines; the ultimate is quite smooth and cylindrical; the telson (style) is attached by an apparently rounded articulation; and the stylet much resembles some of those formerly referred to *C. robusta*. The telson tapers slowly, is smooth, convex along the middle, was about 36 mm. long originally, and is bordered by a slightly-raised rim. The stylet, like a broad sharp blade, about 20 mm. long, also has its edges rimmed. The joint for the telson-head is not well-exposed, but seems to be round and hollow. The place of attachment for the left stylet is not distinguishable, owing perhaps to a lateral shift in the position of these appendages. This specimen, preserved in dark-grey sandstone, micaceous and slightly calcareous, with part of an internal cast of an Orthoceras, is from Benson Knot, and is labelled "C. inornatus;" but the evidence of this specific relationship is supported only by its having been found in the same rock, and by its size suiting the large form referred to "C. inornatus" (but probably *C. stygia*) in the Cambridge Museum (*b*/35, Pl. XI, fig. 1). This specimen is very much like the caudal appendage of *C. stygia*, but it has a *round-headed telson*.

Pl. XII, figs. 2 *a*, 2 *b*. Brit. Mus., No 45154. In the black shale of Lesmahago. Slimon Collection. Right valve outwards, broken in front; the other partially visible. Delicately striate. Seven body-segments traceable, four exposed beyond the valve; obscure lattice-ornament on the third and fourth from the carapace. Style and stylets nearly perfect, but modified by little roundish pits due to decomposition.

12. Ceratiocaris longa, sp. nov. Pl. VI, fig. 3 (?); Pl. XI, figs. 2, 5.

1878. Ceratiocaris robustus, *H. N. & E.* Catal. C. S. Foss., p. 142.
1885. — robusta, var. longa, *T. R. J. & H. W.* Third Report on Fossil Phyllop., Brit. Assoc. for 1885, p. 350.

The specimens Ludlow Museum S., and M. P. G., x $\frac{1}{1\cdot7}$, $_2$, have each a long style and a strong stylet, attached to a broken ultimate segment (Pl. XI, figs. 2 and 5), and were regarded as var. *longa* in the 'Third Report,' p. 350. If any ornament was ever present it may have flaked off. The style or telson in these specimens is too long for either *C. stygia* or *C. papilio;* and C. longa may stand for a specific name.

Specimen Ludlow Museum S. (Pl. XI, fig. 2) is a broad and long telson (at least 63 mm. long), with linear ornament, from the Lower-Ludlow beds at Bow Bridge, Ludlow. Part of an ensiform stylet, with its slightly convex outer margin, shows from beneath it.

Pl. XI, fig. 2, shows a style, ridged and furrowed, and one broad stylet, both flattened out by vertical pressure, with the dorsal face downwards, and represented by an impression, with some ferruginous replacement, and some remnant of test. The latter is on the lower half of the style, and is partly the inside of the embedded test (dorsal face), and partly the whole substance. There are traces of bristle-bases, here and there towards one side (the left-hand side as figured). The specimen lies in greenish-grey, hard sandstone, slightly micaceous.

Pl. XI, fig. 5. Mus. Pract. Geol. x $\frac{1}{1\cdot7}$, $_2$ ('Catal. C. S. Foss.,' 1878, p. 142, *C. robustus*). In hard, olive-green, micaceous shale, from Leintwardine, and closely resembling fig. 2 in its telson (56 mm.) and stylet (25 mm.). In both cases the style has been flattened by pressure; in fig. 5 one half longitudinally has split away, and the other has been made rugose by decomposition.

The specimen figured in the 'Silurian System' and 'Siluria,' and copied in Pl. VI, fig. 3, may very well have belonged to such an individual as the specimen marked S in the Ludlow Museum, and described above. In the 'Silurian System,' 1839, it was termed *Onchus*, pl. 4, fig. 63; *Leptocheles* sp. 'Siluria,' 1854 and 1869, pl. 19, fig. 3.

13. Ceratiocaris robusta, *Salter*, 1860. Pl. X, fig. 10; Pl. XI, figs 8, 9, 12—15.

1851.	Pterygotus leptodactylus, *M'Coy* (in part).			Brit. Palæoz. Foss., fasc. i, p. 175, pl. 1 E, figs. 7 *c*, 7 *d*.
1860.	Ceratiocaris robustus, *Salter*.			Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 158.
1865.	—	—	*H. & E.*	Catal. Foss. M. P. G., p. 79.
1867.	—	—	*Salter*.	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	—	—	Catal. Camb. and Sil. Foss., p. 164.
1877.	—	—	*H. Woodward*.	Catal. Brit. Foss. Crust., p. 71.
1878.	—	—	(part) *H. N. & E.*	Catal. Camb. and Sil. Foss. M. P. G., pp. 84 and 142.
1885.	—	robusta, *T. R. J. & H. W.*		Third Report Pal. Phyll., p. 349; Geol. Mag., 1885, p. 464.
1886.	—	—	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 457.

This species was founded on the caudal appendages of a species the carapace of which has not yet been collated. Hence the species is unsatisfactory to deal with. The original specimens figured by M'Coy, and referred by Salter to a new species, are in the Cambridge University Museum (*a*/925, M'Coy's fig. 7 *c*; *a*/926, fig. 7 *d*). The telson, 32 mm. long (longer than the original figure), is straight, broadly ensiform, 6 mm. wide at its base. The stylets, 20 mm. long, are also relatively broad and ensiform or like a sharp blade. They all seem to have once been faintly fluted and ridged, or costulated. They were obtained from Leintwardine, where they occur in the Lower Ludlow Beds.

Two similar specimens, collected by the late Mr. Lightbody in Upper-Ludlow Beds, "above Ashley Moor," are in the Owens College Museum, Manchester. One of the sets, however, has the stylets nearly as long as the style; whether this was due to variation of growth or to accident, we cannot now decide. The locality is near Richard's Castle, not far from Ludlow.

Oxford Mus. S is a short trifid appendage (not figured), with a style 23 mm. and stylets 13 mm. long; the latter smooth and with a slightly raised rim at the margin; the former faintly fluted and pitted.

Pl. VI, fig. 3. Copied from 'Siluria,' and formerly referred to *C. robusta*, seems to be too large and too much curved for a stylet of the usual form of that species; but it may have belonged to *C. longa* (see page 43).

Pl. X, fig. 10. Mus. Pract. Geol. $\frac{23}{24}$ ('Catal.,' 1878, p. 118). In olive-green shale; slightly micaceous, not calcareous. Lower Ludlow; Leintwardine.

A telson and two stylets, spread out. Dorsal aspect. Telson ridged. Some bristle-bases visible along two rows, one on each side of the main ridge at the broad upper part of the telson (not shown in the figure). Stylets flat, smooth, with the usual rim and slight median ridge.

Pl. XI, fig. 8. Cambridge Mus. *a*/925. "Described by Salter, 'Ann. Mag. Nat. Hist.,' ser. 3, vol. v, p. 158; figured by M'Coy, 'Brit. Pal. Foss.,' pl. i, E, fig. 7 *c* (with 7*d*), as *Pterygotus leptodactylus* erroneously."

This is a telson, with its head retaining some test, flattened and cracked, lying sideways, and bearing some oblique marks, which are possibly remnants of a lattice ornament. The lower part decomposed and rough, but evidently once ridged. One stylet seen, flat and smooth, with delicate lateral rims, its test decomposed.

The fossil occurs in brownish-grey shale: finely micaceous, slightly calcareous on the edge. From the Lower Ludlow Beds of Leintwardine.

Pl. XI, fig. 9. Cambridge Mus. *a*/926. Figured in the 'Brit. Pal. Foss.,' pl. i, E, fig. 7*d*. (See above, fig. 8.) In greenish-grey finely micaceous shale, calcareous on its edge. Leintwardine. A smooth, flat stylet, with slight lateral rims (as in fig. 8). Outer edge rather convex. The upper end obliquely truncate, probably natural, possibly by accident. The test is decomposed and mostly broken away.

Pl. XI, fig. 12. Brit. Mus. No. 58878. In thin, brown, hard shale; finely micaceous. "Linburn, Muirkirk; N.B.—C. W. P."

Telson and two stylets outspread, showing their dorsal aspect. The telson-head is flattened and cracked; the lower part of the telson is somewhat convex, but much corroded; probably once ridged. Its extremity is shown by its impression to have been very thin and sharp, and strongly, but delicately ridged. These caudal spines are shorter than is usual with *C. robusta*.

Pl. XI, fig. 13 *a* and *b*. Brit. Mus. No. 59620 (and its counterpart).

In soft, light brown shale. Buckholm Beds, Gala Group; Meigle Hills, Galashiels. With *Aptychopsis*.

The telson and stylet are represented by a delicate impression, partly tinted with iron-oxide. A small portion of the ultimate segment is represented by a delicate smooth impression (not shown in the figure) above the telson, and of the same width. The joint of telson to the ultimate segment, and of the stylet to the telson are traceable. The telson is neatly ridged and shows two rows of puncta for bristles (fig. 13 *b*); one row as shown in the figure, and another, less easily seen, along the outer furrow. The stylet has a faint trace of having been slightly ridged.

Pl. XI, fig. 14. British Museum, No. 39405. "Lower Ludlow; Leintwardine. Mr. Marston."

Dorsal aspect of a telson, and a separate stylet lying obliquely across and beneath its lower half. Telson-head smooth, retaining some of its test, much corroded, but showing a little of the lattice-pattern very definitely; five or six ridges go off downwards on this face, and the impression of the lowest moiety of the telson shows that the other (under) face was also ridged. A definite row of bristle-bases (pimples in depressions) is visible along one ridge on the dorsal face, and doubtless there was a corresponding row now obscured.

The loose stylet is smooth, but corroded; and has the lateral rims, the slightly convex outer edge, and obliquely truncated joint end that are seen in figs. 8, 9, and others; also observable in *C. papilio, stygia*, and *longa*.

Pl. XI, fig. 15. Brit. Mus. 39404. Hard, olive-grey shale,calcareous on the edge. "L. Ludlow; Leintwardine. Mr. A. Marston."

The under view of style and two stylets, somewhat like fig. 12, but longer and thinner; and towards the end this under side of the telson is marked with a central furrow, which may indicate that the back or outside was angular, and the section like that of a bayonet. Stylets smooth and showing the usual rims and a very slight, central, longitudinal ridge.

14. Ceratiocaris patula, sp. nov. Pl. XI, fig. 11.

1885.	Ceratiocaris robusta (part), *T. R. J. & H. W.*		Third Report Pal. Phyll., p. 350.
1886.	— lata,[1]	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

We find several very small trifid sets of tail-spines, or parts thereof, which at first were thought to belong to small individuals of *C. robusta;* but a few seem to be quite distinct. For some of the larger of these caudal appendages, which we at first (1885) referred to *C. robusta*, we find equivalent styles, and broad blade-like stylets,like long scalene triangles, in *C. papilio, stygia, acuminata*, &c.; but none seem small enough for the several little sets of trifid appendages, more or less perfect, which we have met with. *C. robusta* takes in some small forms (see above); but Oxford Mus. T is relatively broad, and might be termed *patula* (Pl. XI, fig. 11); Brit. Mus. 58878 from Muirkirk, has very narrow members (*angusta*, Pl. X, fig. 9); and one set in the Owens College collection is so neat, symmetrical, and small that it might be called *minuta* (Pl. X, fig. 11).

[1] As this term has been used by Mr. Salter for a species of *Ceratiocaris* (though doubtful), we think it advisable to change it for a synonym (patula).

Oxford Mus. T (Pl. XI, fig. 11) is a little trifid set, near *C. robusta*, and has a style 28 mm. long, and two stylets each 15 mm.; but these appendages are much broader proportionally than those of *C. robusta;* and hence we regard this as a new species, C. PATULA. The stylets are smooth with slight marginal rims; and the style is faintly fluted and pitted (having been spinose) definitely along two rows, one near each margin. It is in Upper-Silurian shale, probably from near Ludlow: as is also Oxford Mus. M, which is much like *C. patula*, but is not figured.

15. CERATIOCARIS ANGUSTA, *T. R. J.* and *H. W.*, 1886. Pl. X, fig. 9.

1885.	CERATIOCARIS, sp. nov. ?, *T. R. J. & H. W.*			Third Report Pal. Phyll., p. 350; Geol. Mag., 1885, p. 465.
1886.	—	ANGUSTA,	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

In the British Museum one of those marked 58878 from Linburn, near Muirkirk, shows a style (21 mm.), tapering, with circular section at base, and apparently smooth, together with a corresponding attached stylet, 16 mm. long. This set differs from the appendages of either *C. papilio* or *C. stygia*, as well as from *C. patula* and *C. minuta*.

16. CERATIOCARIS MINUTA, *T. R. J.* and *H. W.*, 1886. Pl. X, fig. 11; Pl. XI, fig. 10 (?).

1885.	CERATIOCARIS, sp. nov. ?, *T. R. J. & H. W.*			Third Report Pal. Phyll., p. 350; Geol. Mag., 1885, p. 464.
1886.	—	MINUTA,	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

In Owens College Museum, Manchester, is a very delicate little set of caudal appendages (Pl. X, fig. 11). The style (central) shows a circular section at its base (top), about 2 mm. wide, is 12 mm. long, and tapers gently to a sharp point. The lateral stylets are 8 mm. each. All are subcylindrical, and delicately ridged and fluted. From the Lower-Ludlow or Aymestry Limestone, on the old road at Mocktree; collected by the late Mr. Lightbody.

Mus. Pract. Geol. D $\frac{22}{14}$ ('Catal. C. S. Foss.,' 1878, p. 118), from the Lower

Ludlow beds at Leintwardine, is a somewhat similar little set of appendages (three spines), but broken off at the top. What remains of the longest middle one, is 8 mm., of the two lateral stylets 6 mm. (Pl. XI, fig. 10.)

These may represent a very young condition of some of the foregoing species; but they probably belong to a distinct species.

17. Ceratiocaris inornata, *M'Coy*, 1851. Pl. X, figs. 2, 3, 5.

1851.	Ceratiocaris inornatus (Salter MS.),		*M'Coy.*	Brit. Pal. Foss., p. 137, pl. 1 E, fig. 4.
1854.	—	—	*Morris.*	Catal. Brit. Foss., 2nd edit., p. 102.
1859.	—	—	*Salter.*	In Siluria, 2nd (3rd), edit., p. 532.
1860.	—	—	—	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 156.
1865.	—	—	*H. & E.*	Catal. Foss. M. P. G., p. 79.
1867.	—	—	*Salter.*	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	—	—	Catal. Camb. Sil. Foss., pp. 177, 178.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1885.	—	inornata,	*T. R. J. & H. W.*	Third Report Pal. Phyll., pp. 345, 346; Geol. Mag., 1885, p. 460.
1886.	—	—	—	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

This is the third of M'Coy's original species of the genus *Ceratiocaris*. The specimen (Pl. X, fig. 3) *b*/5, in the Cambridge Museum, from Benson Knot, has its carapace ovate-oblong or somewhat boat-shaped in outline, 50 mm. (2 inches) long, height 18 mm.; moderately convex; straight above and arched below (both edges are partly embedded in the matrix of the original specimen, *b*/5, M'Coy's fig. 4). The anterior end (damaged) was neatly rounded, sloping up gracefully from below; the posterior is obliquely truncate from above downwards and outwards, with a slight ogee curve at the top; the postero-dorsal angle distinct, and the postero-ventral angle prominent but blunt. There is no eye-spot. Traces of delicate, parallel, longitudinal striæ are visible on the impressions of the valves in the grey stone, strongest on the middle and ventral regions. Two specimens (one of them good, Pl. X, fig. 2) are in the British Museum, No. 44342, from the same locality. Sometimes the valves have been wrinkled longitudinally and irregularly by pressure, showing that they were thin and toughish (Pl. X, figs. 3 and 5).

The foregoing description does not quite tally with the account of the species

given in the 'Brit. Pal. Foss.,' p. 137, nor with that in the 'Ann. Mag. Nat. Hist.,' l. c., but is based on the original specimens, and not on the *restored* figure in the 'Brit. Pal. Foss.' The diagrammatic figure annexed by Mr. Salter to his note on *C. inornata* in the 'Catal. Camb. Sil. Foss. Mus. Univ. Cambr.,' 1873, p. 178, is used also in connection with two other species at p. 16 and p. 164; and is much like the form which we recognise as *C. Halliana*.

C. inornata approaches *C. papilio* in form, but is smaller and otherwise distinct. There is one from Lesmahago, Lanarkshire, in dark coloured shale, calcareous on its edges, B. M. 59648 (Pl. X, fig. 5), near to *C. papilio* in form, but measuring 34 × 13 mm., and one from Benson Knot, Kendal, Westmoreland, in hard grey sandstone, micaceous, and slightly calcareous, B. M. 44342 (Pl. X, fig. 2), measuring 35 × 14 mm. These proportions are different from those of *C. papilio*. These two are rather smaller than M'Coy's original *C. inornata*, which is about 50 × 20 mm., but have the same proportions, the normal length being $2\frac{1}{2}$ the height; whilst *C. papilio* is larger and has less height in proportion, the length being only twice the height, or even less.

Pl. X, fig. 3. Cambridge Museum *b*/5. "Upper Ludlow;" Benson Knot, Kendal. This was figured by M'Coy, 'Brit. Pal. Foss.,' pl. 1 E, fig. 4, and mentioned by Salter, 'Catal. Cambr. Foss.,' p. 177. It is in hard, dark-grey, micaceous sandstone, slightly calcareous on the edge. There is no eye-spot, the marks being adventitious.

18. Ceratiocaris Ruthveniana, *T. R. J. & H. W.*, 1886. Pl. X, fig. 6.

1885.	Ceratiocaris inornata, *T. R. J. & H. W.*		Third Report Pal. Phyll., p. 345; Geol. Mag., 1885, p. 460.
1886.	—	Ruthveniana, —	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

From among the specimens formerly called *C. inornata* we have removed one of the specimens found at Benson Knot, and marked 44342 in the British Museum (Pl. X, fig. 6), being decidedly different in outline (more ovate), though somewhat similarly marked with longitudinal striæ. It might well be named C. Ruthveniana, in memory of the old geological collector who laboured for very many years in the Kendal district for Professor Sedgwick and others.

The carapace is nearly of the shape of half an egg cut lengthwise; almost straight above, elliptical below, and boldly rounded behind; probably rounded with a blunt point, nearly on the dorsal line, in front. Longitudinally striate.

This is near *C. inornata*, M'Coy, but far more convex on the postero-ventral border, and more fully rounded behind; thus differing in its proportion and shape.

It lies in the usual dark-grey sandstone, micaceous, slightly calcareous on the edges, and containing remains of bivalve shells. Longitudinal striæ are visible in certain lights on the thin brownish film left by the test. The valve is broken and imperfect. It has a strong rim on the ventral margin. The central spot is due to an accidental blow.

19. Ceratiocaris Oretonensis, *H. Woodward*, 1871. Pl. X, fig. 4.

1871.	Ceratiocaris Oretonensis, *H. Woodward.*			Geol. Mag., vol. viii, p. 105, pl. 3, fig. 1.
1878.	—	—	—	Catal. Brit. Foss. Crust., p. 71.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., pp. 346; Geol. Mag., 1885, p. 461.
1886.	—	—	—	Fourth Report, p. 232; Geol. Mag., 1885, p. 459.

This Carboniferous species, described in the 'Geological Magazine' for March, 1871, approaches closely to some of the forms of *Ceratiocaris* found in the Upper Silurian of Benson Knot. The carapace (50 × 24 mm.) is larger than *C. inornata*, M'Coy; but does not attain the size and proportions of *C. papilio*. In re-examining the specimens we find that the anterior end is not so much rounded as in fig. 1 of pl. 3, 'Geol. Mag.,' 1871, but is slightly and obliquely truncate; and the antero-ventral margin is more sloping and less convex; thus the greatest depth of the carapace is in the hinder half. The possible "eye-spot" mentioned at p. 105, *op. cit.*, is too indistinct to be at all recognisable as such. There are four specimens in the British Museum from the Yellow Carboniferous Limestone of Oreton and Farlow, Worcestershire, not well preserved.

Carapace boat-shaped, convex, straight on the back, elliptical below, with the postero-ventral margin more boldly curved than in Pl. X, fig. 7 *a*, and even than in figs. 2, 3, and 5. The mid-ventral border is not nearly so deep in proportion as in fig. 7 *a*. The antero-ventral border is more convex than in the others here referred to. The hinder margin of the best specimen (here figured), is imperfect, but appears to have suddenly sloped off (at an angle of about 35°) from the dorsal edge to a well-curved end. An antero-dorsal angle was probably present but is now wanting.

C. Oretonensis differs from the associated *C. truncata* in being larger, and fuller in the antero-ventral region. Its postero-dorsal slope has a different angle from that of *C. truncata*, fig. 1.

Pl. X, fig. 4. Brit. Museum No. 58884, from Oreton, Worcestershire (Baugh Collection), is in a drab-coloured, coarse-grained, and partly oolitic limestone; a thin layer of shell remains, but it has been much dissolved.

20. CERATIOCARIS TRUNCATA, *H. Woodward*, 1871. Pl. X, figs. 1 *a* and 1 *b*.

1871.	CERATIOCARIS TRUNCATUS, *H. Woodward.*			Geol. Mag., vol. viii, p. 106, pl. 3, fig. 2.
1878.	—	—	—	Catal. Brit. Foss. Crust., p. 72.
1885.	—	TRUNCATA, *T. R. J. & H. W.*		Third Report Pal. Phyll., p. 346; Geol. Mag., 1885, p. 461.
1886.	—	—	—	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

The smaller species occurring with *C. Oretonensis* was described and figured with it in 1871. There are eight specimens in the British Museum, but few of them are at all well preserved. The best carapace measures 35 × 16 mm. The slightly concave truncation of the hinder end is not well rendered in the 'Geol. Mag.,' 1871, pl. iii, fig. 2. Its smaller size, its sharp antero-dorsal angle, and more elliptical ventral curve, distinguish *C. truncata* from its associate, but scarcely separate it, as far as outline is concerned, from some specimens of *C. inornata* at Benson Knot.

Carapace boat-shaped, straight above, elliptical below, curving up less quickly before than behind, where there is a fuller curve going up to meet a truncate edge which slopes at about 50°, with a very slight ogee curve. An indentation and a sharp point mark the front angle.

This is much like Pl. X, fig. 2 (*C. inornata*), but it has a fuller postero-ventral region, and is not so full in the antero-ventral region. The peculiar antero-dorsal angle is not present in *C. inornata.*

Pl. X, figs. 1 *a* and 1 *b*. Brit. Mus. No. 58885, from Oreton, is a left valve in Yellow Carboniferous Limestone. 1 *a* (convex cast) retains a thin whitish film of the test over the greatest convexity; 1 *b* (hollow impression) has some of the shelly film still remaining at its ends.

21. Ceratiocaris solenoides, *M'Coy*, 1849. Pl. VIII, figs. 4 *a*, 4 *b*, 5, 7 *a*, 7 *b*, 8 *a*, 8 *b*, 9 *a*, 9 *b*, 10 *a*, 10 *b*.

1849.	Ceratiocaris solenoides,		*M'Coy.*	Ann. Mag. Nat. Hist., ser. 2, vol. iv, p. 413, with woodcut.
1851.	—	—	—	Brit. Palæoz. Foss., fasc. i, p. 138, pl. 1 E, figs. 5, 5 *a*.
1854.	—	—	*Morris.*	Catal. Brit. Foss., 2nd edit., p. 173.
1860.	Cultellus? (Ceratiosolen?) rectus,		*Salter.*	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 160.
1865.	Ceratiocaris solenoides,		*Huxley & Etheridge.*	Catal. Foss. M. P. G., p. 79.
1873.	—	—	*Salter.*	Catal. Camb. and Sil. Foss., p. 178.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1878.	—	—	*H. N. & E.*	Catal. Foss. M. P. G., p. 142.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., p. 347; Geol. Mag., 1885, p. 461.
1886.	—	—	—	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

Prof. M'Coy founded the genus on this species and *Emmelezoe elliptica* in 1849; but the original specimens in the Cambridge Museum (*b*/40, *b*/41) are not drawn with sufficient exactness in M'Coy's figs. 5 and 5 *a*. The carapace is elongate, subcylindrical, slightly convex on the sides, with an even elliptical anterior curve, and an oblique, slightly curved truncation posteriorly. There are faint traces of longitudinal striæ on the hollow impressions of the valves in the matrix, and there is a slight impression of the ventral rim. The large valve is 43 mm. long (M'Coy's fig. 5); the smaller specimen (fig. 5 *a*) 27 mm., is apparently broken behind, but does not show the double valve there as given in the figure. We cannot distinguish any "nuchal furrow," nor is there any "eye-spot;" a mark consisting of two minute adventitious pits in the anterior third of one of the specimens, and a little hole in another, have been mistaken for it. Mr. Salter in 1860 thought that these little fossils were Molluscan;[1] but they certainly may well claim to be Phyllopods, as he afterwards recognised them to be. There are other specimens in the Cambridge Museum. In the British Museum there are four rather large, but not well-preserved, specimens (44342). All the above come from the Upper-Ludlow grey micaceous sandstone of Benson Knot, near Kendal, Westmoreland.

[1] See 'Ann. Mag. Nat. Hist., l. c., p. 159, *note;* and Sedgwick's 'Lists of Kendal Fossils,' Wordsworth's Letters on the Lakes,' 1843—46, Appendix.

The carapace is elongate, boat-shaped, straight above, curved below, rounded to a blunt point (on the medial line) in front; truncated obliquely from above downwards and backwards behind, making with the postero-ventral upward curve a blunt point below the medial line.

Pl. VIII, figs. 4 *a*, 4 *b*. Cambridge Museum *b*/40, marked "*Ceratiocaris solenoides*, M'Coy." In dark-grey, micaceous, fine-grained sandstone, slightly calcareous; from Benson Knot, Kendal, Westmoreland. This is an imperfect carapace, embedded whilst open to some extent, and therefore extra wide in its dorsal aspect. Prof. M'Coy's fig. 5 *a* is a sketch of this specimen free of matrix; but the broken end is not correctly given; there is no eye-spot at all, and the figure is reversed.

Pl. VIII, fig. 5. Cambridge Museum, with *b*/8. Benson Knot. In the same sandstone as *b*/40. The back and the left-hand (posterior) end in the figure are obscured by matrix.

Pl. VIII, figs. 7 *a*, 7 *b*. Cambridge Museum *b*/41, marked "*Ceratiocaris solenoides*, M'Coy." Benson Knot. In the same sandstone.

This seems to be M'Coy's fig. 5; if so, the sketch is reversed, and there is no eye-spot (only a little accidental hole near the anterior end). It has traces of longitudinal striæ, and of the ventral rim.

Pl. VIII, figs. 8 *a*, 8 *b*. Cambridge Museum *b*/8. Benson Knot. In the same sandstone. The left-hand end in the figure is obscured by matrix (anterior).

Another, marked 'R. I. M., Benson Knot,' is the internal cast of a right valve, partly buried at each end. There is some obscure lineation; fine longitudinal striæ being visible (under the lens) on the anterior half.

Pl. VIII, figs. 9 *a*, 9 *b*. Mus. Pract. Geol. x $\frac{1}{18}$ (Cat., 1878, p. 142). In Upper-Ludlow dark-grey, micaceous, fine-grained sandstone; from Benson Knot, Kendal. A convex cast; smooth; with the ends partially obscured, especially that at the left-hand of the figure.

Pl. VIII, figs. 10 *a*, 10 *b*. Cambridge Museum, with *b*/41. In dark-grey, micaceous, fine-grained sandstone, slightly calcareous; from Benson Knot. It has very faint traces of longitudinal striæ, and a slight trace of the ventral rim. There are two small adventitious pits on the anterior third of the valve, but no ocular spot.

22. Ceratiocaris gobiiformis, *T. R. J. & H. W.*, 1885. Pl. VIII, figs. 6 *a*, 6 *b*, 11 *a*, 11 *b*.

1885. Ceratiocaris gobiiformis, *T. R. J. & H. W.* Third Report Pal. Phyll., Brit. Assoc., p. 347; Geol. Mag., 1885, p. 462.
1886. — — — Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

A form closely approaching *C. solenoides* in shape, but smaller, less acute in front, usually more vertically truncate behind, and much more convex on the ventral border, accompanies *C. solenoides* in the Upper-Ludlow sandstone of Benson Knot. One of the specimens marked *b*/8, Cambridge Mus., is 27 mm. long by 9 mm. high; one in the Brit. Mus., No. 44342, is 30×10 mm. The valves seem to have been smooth. They are somewhat boat-shaped in outline, and distantly resemble a deep-bodied, blunt-headed little fish, such as a gudgeon, without its tail; convex; straight or nearly so in the back, strongly curved below; rounded to a very blunt angle in front, obliquely truncate behind. It is possible that this may be a varietal or sexual form of *C. solenoides*, but it seems to be sufficiently well separated from its ally to require a distinctive name, so we refer to it as C. gobiiformis.

This is near *C. solenoides*, but is relatively broader (higher) and shorter; the ventral margin is much more convex, and the front end blunter.

Pl. VIII, figs. 6 *a*, 6 *b*. Brit. Mus., one of the specimens marked No. 44342. In dark-grey, micaceous, fine-grained sandstone, slightly calcareous; from Benson Knot.

Pl. VIII, figs. 11 *a*, 11 *b*, 11 *c*. Cambridge Museum *f* 142. In dark-grey sandstone, calcareous; from Benson Knot. In this small valve (10×4 mm.), the ventral border is still somewhat embedded in the matrix; and there are three small adventitious accretions on the apparently smooth surface.

23. Ceratiocaris Salteriana, *T. R. J. & H. W.*, 1885. Pl. VII, figs. 1 *a*, 1 *b*, 2, 3.

1885.	Ceratiocaris Salteriana, *T. R. J. & H. W.*			Third Report Pal. Phyll. Brit. Assoc., p. 348; Geol. Mag., 1885, p. 462.
1886	—	—	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

Four specimens, in rather different states of preservation, from the Lower-Ludlow strata, indicate the existence of a distinct species of *Ceratiocaris*, having nearly oblong carapace-valves, with almost equally rounded ends, and ornamented with delicate but distinct horizontal parallel lines, rather wide apart.

One of these, a carapace, M. P. G. D $\frac{22}{14}$ *a*, 1 & 2, from Bow Bridge, Ludlow, well preserved, is 30 × 15 mm., straight on the back, rounded at the ends. The two counterparts are here figured, figs. 1 *a*, 1 *b*.

In very fine-grained, grey, micaceous, and partly calcareous mudstone, breaking unevenly, are the two light-brown, suboblong valves, one shifted on the other, and more or less buried in the matrix at the dorsal edge; smooth, with delicate, parallel, longitudinal striæ, a centimètre apart where broadest, running closer to each (some dying out) near the ventral margin. Marginal rim strong and narrow.

The transverse markings are of mechanical origin, being due to small narrow patches of the test remaining alongside of numerous obliquely-transverse cracks.

In fig. 1 *a*, D $\frac{22}{14}$ *a* 2, the right valve is uppermost, but is only partly seen, its dorsal edge and both of its angles being lost in the matrix. [The antero-ventral curve is rather too bold in the drawing.] The raised striæ are seen on the upper left-hand portion (posterior third of the right valve), one centimètre apart, and ending abruptly in the posterior rim.

The lower part of the specimen is the inside of the left valve, with sunken striæ on the inner face of the test.

Fig. 1 *b*, D $\frac{22}{14}$ *a* 1, is the counterpart of two-thirds of the compressed carapace.

In the Cambridge Museum, *a*/694 (Fletcher Collection), marked "Dudley; in upper shale," which is a dark-grey, very fine-grained, and slightly calcareous mudstone, of the Lower Ludlow formation, is a similar carapace (Pl. VII, fig. 2), nearly as well preserved as fig. 1, and measuring 30 × 13 mm. It is mentioned by Salter in the 'Catal. Camb. and Sil. Fossils Mus. Cambridge,' 1873, p. 129.

The ventral margin has a distinct raised rim. The striæ and interspaces differ in tint of colour on the cast. Some internal organs (teeth?) have caused a little break or hole, and a derangement of the striæ in the antero-dorsal region. The valve is suboblong. The hinder margin has a slight ogee curve; the front is

broken, but probably ended originally in a neat angle at or near the dorsal margin. The parallel striæ are slightly raised on the remaining patches of the thin, smooth, brown test. Striæ sometimes one centimètre apart, but closer together towards the ventral edge. Marginal rim strong.

Another specimen (Pl. VII, fig. 3), also from the Lower Ludlow series, evidently belongs to the same species. It is the specimen M in the Oxford Museum (Grindrod Collection), and it is preserved in greenish-grey, micaceous, and calcareous mudstone. This suboblong carapace is broken at the ends, with the right valve embedded. An imperfect thin film of the other, retaining a small patch of fine longitudinal striæ near the ventral margin in the hinder half, covers the obscure subconvex mass representing the contents of the carapace. The anterior fracture shows this little mass to contain some minute indefinite remains of organic parts, like two vertical rows of roundish spots (? sections of limbs).

The posterior fracture exhibits four of the body-segments, preserving their smooth test, within the carapace and continuous with others still further in. Outside the carapace are the penultimate and ultimate segments. The last segment (6 mm. long) is marked with faint striæ, slightly oblique from above downwards and backwards. A style (about 12 mm.) and one stylet (7 mm.), both smooth and rather broad or dagger-shaped, are attached by an indistinct articulation.

We wish to associate this rare but distinct species of *Ceratiocaris* with the name of our deceased friend Mr. J. W. Salter, who worked so long and so well on these and allied *Phyllopoda*.

24. Ceratiocaris laxa, *T. R. J. & H. W.*, 1886. Pl. VIII, fig. 12; Pl. X, fig. 12.

1885.	Ceratiocaris stygia, *T. R. J. & H. W.*		Third Report Palæoz. Phyll., p. 345; Geol. Mag., 1885, p. 396.
1886.	—	laxa, —	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

One of the specimens in the British Museum marked 59648, from Lesmahago, is a small acute-ovate carapace (25 × 13 mm.), pointed in front, truncate behind, with which is associated a complete, but somewhat crushed, body of thirteen or fourteen segments, five (15 mm.) of which are external, and have appended to them a neat trifid set of long, narrow, sharp appendages. The strongest is the telson, delicately ridged, and 17 mm. long; and the others, about 8 mm. long, are the stylets.

This small and very delicate specimen (Pl. VIII, fig. 12), in black shale, with a small, thin, calcareous vein, from Lesmahago, exhibits on the anterior part of its

thin sub-ovate carapace excessively fine, parallel, longitudinal striæ (Pl. X, fig. 12). This form differs from any other we know. Its looseness of structure suggests the name LAXA.

On another of the specimens in the British Museum, marked 59648, from Lesmahago, are three loose small *bodies*, without carapaces (Third Report, p. 345). The largest has thirteen or fourteen segments (45 mm. in length), some of which are obliquely striate. Five measure 25 mm., and the last one 10 mm., equal to three of the others. The telson is 20 mm. long. Another such specimen, smaller and narrower, 35 mm. long, has fourteen (?) segments; the last one 7 mm. long; appendages imperfect.

These may be the loosened and shifted abdomens of either young individuals of *C. stygia* or *C. papilio*, both common at Lesmahago, or more probably of *C. laxa*. They cannot be mistaken for the Carboniferous *Acanthocaris*, Peach, or the Devonian *Campecaris*, Page.

25. CERATIOCARIS COMPTA, *T. R. J. & H. W.*, 1886. Pl. VII, figs. 10 *a*, 10 *b*.

1885.	CERATIOCARIS CASSIA (part),	*T. R. J. & H. W.*		Third Report Pal. Phyll., p. 348; Geol. Mag., 1885, p. 463.
1886.	—	COMPTA,	—	Fourth Report, p. 232; Geol. Mag., 1886, p. 459.

The specimen H in the Ludlow Museum, from Trippleton, is a very small, ovate, filmy relic of a valve (13 × 7 mm.), with a loose abdomen of four segments (12 mm.), and a neat little outspread trifid caudal appendage; style about 10 mm. long, stylets 6 mm. These all are flat, smooth, and thickened at their edges.

The carapace was subovate, sharp in front, and obliquely truncate behind. The segments, flattened and split along the middle by vertical pressure, are delicately striate (fig. 10 *b*), with oblique lines (outwards and downwards) on each side, suggesting the name COMPTA, which we propose for this species as being distinct from any known form.

Pl. VII, figs. 10 *a*, 10 *b*, Ludlow Museum H, is from the Lower-Ludlow, greenish-grey, finely micaceous mudstone, not calcareous; and was collected by Mr. Marston at the roadside quarry south-east of Trippleton.

This small valve is represented by a black film, nearly ovate. The abdomen and three caudal appendages have been laid out symmetrically by vertical pressure. The oblique lateral striation on the segments is very plain under a lens (fig. 10 *b*).

26. Ceratiocaris cassia, *Salter*, 1860. Pl. VII, figs. 7 *a*, 7 *b*, 7 *c*, 7 *d*, 7 *e*.

1860.	Ceratiocaris cassia, *Salter*.			Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 159.
1865.	—	—	*Huxley & Etheridge*.	Catal. Fossils M. P. G., p. 79.
1867.	—	—	*Salter*.	In Siluria, 3rd (4th) edit., p. 516.
1877.	—	—	*H. Woodward*.	Catal. Brit. Foss. Crust., p. 70.
1878.	—	—	*H., N. & E.*	Catal. Camb. Sil. Foss. M. P. G., p. 141.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., p. 348; Geol. Mag., 1885, p. 463.
1886.	—	—	—	Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

C. cassia is recognised on an interesting slab, of which one counterpart is in the Ludlow Museum (E and F) and the other in the Museum of Practical Geology at Jermyn Street, London (x $\frac{1}{1}$). Neither gives the form quite complete; the lower specimen on each slab seems to have been much modified. They are the originals seen and noticed by Mr. Salter.

The carapace is suboblong, horizontally striate; truncate, with an ogee outline behind; pointed in front; postero-dorsal angle above the median line; anterior angle on the median line; 20 mm. long, and 11 mm. high. Of the body-segments one or two are exposed, altogether 6 mm. in length, longitudinally or obliquely striate. Telson and stylets rather short, sharp, delicately ridged; stylet 4 mm., style about 9 mm. long.

Figs. 7 *a*, 7 *b*, Ludlow Museum E and F; figs. 7 *c*, 7 *d*, 7 *e*, M. P. G. x $\frac{1}{1}$. From Lower-Ludlow beds, at a roadside quarry, Trippleton Farm, near Leintwardine. Marked "*Ceratiocaris cassia*, Salter." Both counterparts consist of a greenish-grey, rather hard mudstone, fine-grained, slightly micaceous, and somewhat calcareous, especially along thin whitish seams at the edge.

Two carapaces are represented by two pairs of thin brown valves, much squeezed and crumpled. The upper carapace retains its ogee hinder border, and its pointed front extremity, both much above the medial line, but on the long axis of the valves. Marginal rim strong; the surface is ornamented with delicate, longitudinal, and parallel striæ. The lower carapace is more distorted than the other, blunter in front, and squeezed into a narrower shape.

Besides the wrinklings by pressure, there are irregularities of the surface due to internal organs in the anterior moiety of each carapace. In the larger (upper) carapace there is a minute, flask-shaped, pitted depression just beneath a very small pimple in the anterior region. At first sight these marks have the look of *ocular* tubercles; but after careful examination we are not inclined to give them that importance.

Each individual has the ultimate body-segment in place, with short caudal spines. A very delicate oblique striation is present on the exposed segment of the lower specimen. The telson shows minute pittings in the upper specimen of fig. 7 *a*.

Projecting from the edges of these carapaces are broken pieces of ventral rims of other specimens. These remnants are figured on a larger scale in figs. 7 *d* and 7 *e*; and a piece of a rim (fig. 7 *b*) from fig. 7 *a* is given to show the characteristic arrangement of the striæ running into the marginal rim, and determining the nature of figs. 7 *d* and 7 *e*.

27. CERATIOCARIS CASSIOIDES, *T. R. J.* and *H. W.*, 1886. Pl. III, fig. 9; Pl. IV, fig. 7; Pl. VII, figs. 4, 5, 6.

1878. CERATIOCARIS VESICA (part), *Huxley, Newton, and Etheridge.* Catal. Foss. M. P. G., p. 142.

1885. — SALTERIANA (part), C. CASSIA (part), and CERATIOCARIS, sp. nov. ?, *T. R. J. & H. W.* Third Report, pp. 348, 349; Geol. Mag., 1885, pp. 462, 463.

1886. — CASSIOIDES, *T. R. J. & H. W.* Fourth Report, p. 231; Geol. Mag., 1886, p. 458.

Carapace deeply boat-shaped, very slightly convex on the back at the anterior third, where it slopes down to the front; pointed or beaked in front, boldly curved below, and obliquely truncate, with an upward and outward ogee slope behind. Surface smooth; much wrinkled by pressure, showing its soft but tough consistency. The ultimate segment has faint oblique striæ from above downwards and backwards. The telson in one specimen (Pl. IV, fig. 7) is 11 mm. long. Stylet shorter.

Somewhat similar to *C. cassia*, in the characters of the carapace, but larger and otherwise different. The specimens have more abdominal segments exposed and proportionally longer caudal appendages. The species might be conveniently named C. CASSIOIDES.

These specimens should be studied in the order of Pl. VII, fig. 6, fig. 4, fig. 5; Pl. III, fig. 9; and Pl. IV, fig. 7, for accurate and gradational comparison.

Mus. Pract. Geol. x $\frac{1}{26}$ ('Catal. C. S. Foss.,' 1878, p. 142), has its carapace and abdomen preserved in place. This is marked "*Ceratiocaris vesica*, Salter; Lower Ludlow; Leintwardine;" and is in an olive-grey mudstone, finely micaceous, and

partly calcareous; casts of small Brachiopoda and *Cardiola interrupta* are present on a bed-plane. It differs very much from *Physocaris vesica*, although nearly of the same size. The carapace is subtriangular, 25 mm. long and 14 mm. deep at the middle of the ventral margin (Pl. VII, fig. 6.) The back is straight, but curved down at both ends to meet the steep upward slopes of the lower margin. The abdomen (15 mm. long) comes out, as usual, from the upper part of the hinder region. The carapace is represented by a thin, brownish, wrinkled film; the irregular crumpling in the antero-dorsal region is probably due to the presence of hard remains of internal organs. [The front extremity is not quite so distinct as in the drawing.] Four body-segments and a small part of the caudal appendages remain attached. The ultimate (6 mm.) and penultimate segments retain their test, which is obliquely striated.

Specimen Ludlow Mus. J (from Trippleton, near Leintwardine) has a smaller but nearly similar carapace (22 × 12 mm.), gently convex on the back, deeply curved below, and with almost equal, sharp dorsal angles in front and behind.

Specimen Ludlow Mus. K, from Trippleton, near Leintwardine, has a carapace (23 × 12 mm.), five (?) abdominal segments (10 mm.), and appendages, of which the style (pitted with bases of little spines) is imperfect, but a stylet measures 5 mm. (Pl. VII, fig. 4).

Much narrower than those above mentioned is B. M. 39400 (Pl. III, fig. 9), which has been squeezed, so as to have its outline modified. It is in olive-grey micaceous mudstone, weathering brownish, from the Lower-Ludlow beds at Church Hill, Leintwardine.

The part of carapace preserved is much crumpled, but seems to have been smooth. The converging wrinkles at the hinder end may have been altogether due to pressure. There are some obscure indications of internal organs, including an elongate, slightly curved, fimbriated, branchial (?) appendage, or displaced antenna, lying lengthwise in the ventral region. There are also obscure remains of abdominal segments and appendages, altogether about 17 mm. long. A hollow cast belonging to the same species, B. M. 44342, from Benson Knot, has a better preserved outline. It is nearly oblong, slightly arched above and below, truncate with hollow curve behind, pointed and mucronate in front. In outline this approaches Pl. IV, fig. 7, but is larger and proportionally deeper.

As in *C. cassia* so in *C. cassioides*, the carapace has been apparently thin and tough, so as to allow of it being crumpled very much. This condition and the presence of harder parts of their internal organs beneath give rise to various irregularities of the surface, in some cases simulating ocular tubercles. There are, however, no real eyespots. Some of the superficial derangements may be due to the attachment of the muscles of the jaws within the carapace.

Pl. IV, fig. 7. Oxford Museum Q. Lower Ludlow. In the usual mudstone,

calcareous at the edge. Here we have probably two valves, pressed together and crumpled; a film of *smooth* test is visible; the segments are continued inwardly. An obscure, filmy, lineated, sharply-elliptical body, lying obliquely just above the anterior point of the valve, may be a relic of the *rostrum*. There are three outer segments and a strongly-ridged, sharp telson.

Pl. VII, fig. 4. The specimen, Ludlow Museum K, is in a greenish-grey, non-calcareous, finely micaceous mudstone, Lower Ludlow. From the old roadside quarry south-east of Trippleton. Collected by Mr. A. Marston.

Carapace with almost perfect outline of the embedded left valve, but with only a fragment of the outside of the right valve (posterior third); purplish in tint; marked with parallel striæ wide apart, and with transverse cracks. The marginal rim is strong, as shown by the impression.

There are three abdominal segments exposed, and indications of others. The caudal appendages are rather obscure.

Pl. VII, fig. 5. Oxford Museum L. In Lower-Ludlow yellowish-grey, finely micaceous mudstone, not calcareous.

Carapace represented by a hollow impression of the right, and a postero-dorsal fragment of the left valve. The outline is well preserved, subovate, straight on the postero-dorsal edge, which terminates with an angle above the medial line of the valve, over a slightly ogee curve on the truncate end. The anterior curves meet in an elegant point almost on the medial line. A small mass of obscure organic matter occupies the antero-dorsal region. Indistinct longitudinal striæ are traceable on the remnant of the left valve. The ventral rim of the right valve is indicated by a strong impression on the matrix, with a few delicate striæ near by. Three abdominal segments, with a telson and one stylet, are attached; all apparently smooth, but under the microscope there are traces of a fine lineation on the segments. The appendages, not exposed to their ends, are rugose with pits, due probably to decomposition.

28. Ceratiocaris (?) longicauda (*D. Sharpe*), 1853. Pl. XI, figs. 16 *a*, 16 *b*.

1853.	Dithyrocaris? longicauda, *D. Sharpe.*	Quart. Journ. Geol. Soc., vol. ix, p. 158, pl. 7, fig. 3.
1885.	Ceratiocaris? longicauda, *T. R. J. & H. W.*	Third Report Pal. Phyll., p. 354.
1886.	— — —	Fourth Report, p. 233; Geol. Mag., 1886, p. 460.

The ultimate segment and trifid appendage of a small Ceratiocarid of uncertain

genus. Except that the central spine (style) is the longest of the three, and the stylets have smooth edges, this little fossil might be matched with C. E. Beecher's *Elymocaris siliqua*, p. 13, pl. 2, fig. 1, of the 'Report Geol. Surv. Penns.' 1884. The segment (about 8 mm.) was described by Mr. D. Sharpe as "simple and rounded;" the spines as "lancet-shaped," . . . "the middle one somewhat rounded and twice as long as the lateral plates, which are nearly flat." . . . "From the upper division of the Lower Silurian formation at Sazes, in the Serra de Bussaco, near Coimbra." Collected by Senhor Carlos Ribeiro. In the Geological Society's Museum, Cabinet 11, Drawer P.

This set of spines is much stouter than the specimens Mus. Pract. Geol. D $\frac{22}{14}$, Pl. XI, fig. 10, and both stouter and shorter than the somewhat similar small set in the Owens College Museum (Pl. X, fig. 11).

The telson is relatively short (about 10 mm.), smooth, ridged along the middle, having a triangular section, and rimmed at the edges. The stylets (about 6 mm. long) are strong, smooth, and rather thickened towards their outer edges.

This foreign (Portuguese) form, being within our reach, has been studied in the Geological Society's Museum, Burlington House, and shows some interesting features. Its scientific name was given by the late Mr. D. Sharpe under the supposition that the fossil was a *Dithyrocaris* with a longer abdomen than usual; but its smooth and long ultimate segment, and its smooth style, seem to remove it from that genus, as intimated in our 'Third Report,' p. 354. It is probably distinct also from *Ceratiocaris;* it has some analogy with the Devonian *Elymocaris;* but at present we cannot fix its generic place.

The caudal extremity of *Ceratiocaris aculeata*, J. Hall ('Geol. Surv. New York,' vol. iii, part i, 1859, p. 422*, and part ii, 1861, pl. 80A, fig. 10), from the "Waterlime Group," offers some alliance with this Portuguese form, though of much larger size; for its style appears to be short and strong, with a median ridge.

This interesting little Portuguese fossil is contained in a small nodule (27 × 23 mm.), broken open, dark grey within and ochreous outside; not calcareous; containing several scattered minute *Primitiæ* (?). Around the central fossil the matrix is blacker and rougher in section (limonitic).

On the face of each half is the hollow cast of a nearly cylindrical, but slightly tapering, tubular ultimate segment, 7 mm. long, by 5 mm. at the top, and 3 mm. at its end, succeeded by a style or telson, 10 mm. long in the specimen, but not quite perfect. Ochreous casts and impressions of the upper and lower parts of the style are preserved in the nodule; and they show that the style had a definitely triangular section, with a ridge on its outer face, and slightly raised rims along the edges.

By the side of the telson are two blade-like stylets, neither perfect (6 mm. long, as preserved), smooth and flattish, but thicker along their outer half.

There are also known some doubtful British forms that have been referred to *Ceratiocaris*, for illustrations of which we direct attention to the figures given with the original descriptions (see below).

29. Ceratiocaris decora (*Phillips*), 1848.

1848.	Onchus decorus,	*Phillips.*	Mem. Geol. Surv., vol. ii, part 1, p. 226, pl. 30, figs. 5, 5 *a*.
1860.	Ceratiocaris decorus,	*Salter.*	Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 158.
1867.	—	— —	In Siluria, 3rd (4th) edit., p. 516.
1877.	—	— *H. Woodward.*	Cat. Brit. Foss. Crust., p. 70.
1885.	—	decora, *T. R. J. & H. W.*	Third Rep. Foss. Phyll., p. 350; Geol. Mag., 1885, p. 465.

A small obscure telson (?), 13 mm. long; according to Phillips from the Upper Ludlow with Fish-defences (*Onchi*) either near Mathon Lodge, or at Hales End, in the Malvern district; but according to Salter from the "Ludlow rock of Freshwater East, Pembrokeshire."

30. Ceratiocaris (?) lata, *Salter*, 1866.

1866.	Hymenocaris? latus,	*Salter.*	Mem. Geol. Surv., vol. iii, p. 240.
1866.	Ceratiocaris?	— —	Ibid., p. 294, woodcut fig. 5.
1867.	—	— —	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	— —	Cat. Camb. Sil. Foss., p. 16.
1877.	—	— *H. Woodward.*	Cat. Brit. Foss. Crust., p. 71.
1885.	—	lata, *T. R. J. & H. W.*	Third Report, p. 351; Geol. Mag., 1885, p. 465.

The specimen is in the Cambridge Museum (*b*/299), and shows five (?) abdominal segments crushed endwise, so as to be shortened (12 mm.) and widened (28 mm.). The woodcut referred to is a *restoration*. The specific and even generic relationship is obscure, perhaps nearest to *Hymenocaris*. From the Upper-Tremadoc Slate at Garth, east of Portmadoc; collected by Mr. D. Homfray.

31. Ceratiocaris (?) insperata, *Salter*, 1866.

1866.	Ceratiocaris? insperatus,		*Salter.*	Mem. Geol. Surv., vol. iii, p. 295, woodcut, fig. 6.
1867.	—	—	—	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	—	—	Cat. C. S. Foss. Cambridge, p. 16.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1885.	—	insperata,	*T. R. J. & H. W.*	Third Report, p. 351 ; Geol. Mag., 1885, p. 466.

In the Cambridge Museum (*b*/343), not well figured in the woodcut referred to, is an obscure remnant of an ultimate abdominal segment, with clear indications of a trifid appendage ; the telson or central spine seems to be the longest, but all three are broken off above their points. The telson is about 35 mm. long. From dark-grey shales between the Lower and Upper-Tremadoc Slates in a railway-cutting above the village of Penmorfa, Portmadoc. Collected by Mr. D. Homfray. Mr. Salter thought that it belonged to the same species as the foregoing.

32. Ceratiocaris (?).

An obscure hinder moiety (25×12 mm.) of a carapace possibly referable to *Ceratiocaris* is in the Mus. Pract. Geol., $\frac{13}{84}$, 'Catal. C. S. Foss.,' 1878, p. 72. From the "Upper Llandovery ; Onny River." 'Third Report Foss. Pal. Phyll.,' 1885, p. 352 ; 'Geol. Mag.,' 1885, p. 466.

33. Ceratiocaris (?) perornata, *Salter*, 1878.

1878.	Ceratiocaris perornatus (Salter MS.),		*Huxley, Newton, and Etheridge.*	Catal. Camb. Sil. Foss. M. P. G., p. 142.
1885.	—	? perornata,	*T. R. J. & H. W.*	Third Report, p. 352; Geol. Mag., 1885, p. 466.

Very little is known of this obscure form. One specimen, M. P. G. x $\frac{1}{11}$, and two in the Cambridge Museum, are only fragments (one rather more than an inch long, and the others less) of what seem to be cylindrical spines (like those of Echinoderms), about 5 mm. in diameter, two pitted all over (?) and one tuberculate. They are from the Upper Ludlow of Benson Knot, near Kendal, Westmoreland.

II. Genus Xiphocaris, *T. R. J. & H. W.*, 1886.

Ceratiocaris (?), *Salter, T. R. J. & H. W.*
Xiphocaris, *T. R. J. & H. W.*

Known only by its long, curved, blade-like telson.

1. Xiphocaris ensis (*Salter*), 1860. Pl. V, figs. 7 *a*, 7 *b*, 7 *c*, 7 *d*.

1860.	Ceratiocaris ? ensis,	*Salter.*		Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 159.
1867.	—	—	—	In Siluria, 3rd edit., p. 516.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1885.	—	—	*T. R. J. & H. W.*	Third Report Pal. Phyll., p. 351 ; Geol. Mag., 1885, p. 465.
1886.	Xiphocaris	—	—	Fourth Report, p. 233 ; Geol. Mag., 1886, p. 460.

In the Oxford Museum we find the original fossil described by Mr. Salter in 1860, namely specimen O, a large telson (Pl. V, fig. 7 *a*), nearly 6 inches long, lying on its side and flattened, bulbous at its proximal end, sword-shaped, with an incurved apex, a crenato-serrate convex dorsal margin, and nearly flat sides, which have a sub-central rib, giving a lozenge-shaped section (fig. 7 *b*). Not quite perfect at the point, this telson is 145 mm. long, 16 mm. broad at the bulb, and 13 mm. below it. The subcentral line is a low ridge at the top. This is traceable nearer the outside lower down; and it becomes a central furrow below. Traces of test remain here and there. Both edges are minutely serrated (figs. 7 *c* and 7 *d*). Along and close to the inner (concave) edge there is a multiple row of pits (the bases of the small spines or prickles), in threes and fours, obliquely set along the upper half, below the bulbous portion; and these are feebler and fewer lower down, and die out downwards in a less regular, thinner, and more scattered series, until they become an irregular row of single pits. Coarsely granular, radiating, and other markings, due to casts of parasitic Polyzoa, cover the bulb and occur here and there on the spine itself. The lowest portion is smooth.

The arrangement of the pitting along the concave edge may by itself indicate a distinct *generic* relationship. It reminds us of Barrande's *C. debilis*, as figured in his 'Sil. Syst. Bohême,' vol. i, Suppl. pl. 18, figs. 26—28, and pl. 31, fig. 16—19. Altogether its large size, its curvature, and the serration on both the upper and the lower edge, and the profuse spination (as shown by pits) on the latter

distinguish our fossil from other telsons; and more particularly its lozenge-shaped sectional area of an unequal rhombic form, blunter at the outer (upper) and convex edge than on the other, the ridge along the sides not being quite on the medial line, but nearer the outer than the inner edge. Neither the carapace nor the stylets of this species are known as yet. We have proposed the name Xiphocaris[1] for this rare genus.

M. Barrande's *Ceratiocaris primula* (see our 'Third Report,' p. 357) has a style (or stylet?) with lozenge- or diamond-shaped section; but, though curved, it is of different dimensions and is pitted all over.

Pl. V, fig. 7. Oxford Museum O (Grindrod Collection). Collected by Mr. A. Marston; marked "*Cerat. ensis*;" from the Lower Ludlow series at Leintwardine, Shropshire, according to Mr. Salter ('Ann. Mag.,' *l. c*).

In hard, grey, micaceous mudstone, with a few small, obscure, organic markings; calcareous at the edge.

There is another similar but much less distinct specimen of *Xiph. ensis* in the Oxford collection, from near Ludlow.

III. Genus Physocaris, *Salter*, 1860.

Ceratiocaris, *Salter*.
Physocaris, *Salter, T. R. J. & H. W.*

Known only by a unique specimen of an orbicular, probably bladder-like, small, thin carapace, with its abdomen and caudal appendages.

1. Physocaris vesica, *Salter*, 1860. Pl. VII, figs. 8 *a*, 8 *b*.

1860. Ceratiocaris (Physocaris) vesica, *Salter*. Ann. Mag. Nat. Hist., ser. 3. vol. v, p. 159, woodcut fig.
1865. — — — *Salter & H. Woodward*. Chart Foss. Crust., p. 17, fig. 8.
1865. — — — *Huxley & Etheridge*. Catal. Foss. M. P. G., p. 79.
1867. — vesica, *Salter*. In Siluria, 3rd (4th) edit., p. 517.
1877. — (Physocaris) vesica, *H. Woodward*. Cat. Brit. Foss. Crust., p. 72.
1878. — vesica, *Huxley, Newton, & Etk*. Cat. Foss. M. P. G., p. 142.
1884. — — *La Touche*. Handbook Geol. Shropsh., pl. 22, fig. 816.

[1] Ξίφος, a sword; καρίς, a shrimp.

1885. Physocaris vesica, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 353; Geol. Mag., 1885, p. 467.

1886. — — — Fourth Report, p. 233; Geol. Mag., 1886, p. 460.

Of this curious fossil Phyllopod, having a small bladder-like carapace, described by Mr. Salter in 1860, only one specimen is known. It is in Mr. Theodore Salwey's collection at Ludlow. It differs slightly from Mr. Salter's woodcut figure, being larger, and showing an appearance of having been broken away to a little extent near one end so as to leave a broad notch at the slope behind an angle, and these together constitute the prominence in Mr. Salter's woodcut figure. If continued over this notch, the outline of the shell would be nearly that of a broad oval, whereas now it is broadly and obliquely pyriform (25 × 18 mm).

This specimen of *Physocaris vesica*, Salter, we consider as having had its abdominal segments shifted further upwards, and turned over on their axis, after death; and therefore as having been figured both by Mr. Salter, and in Pl. VII, fig. 8, upside down. The annexed woodcut shows what we consider to have been the natural position of the carapace and abdomen.

The relative position of the animal in these Phyllopods is indicated by the telson occupying the upper part of the caudal appendages attached to the abdomen. In this instance, however, the abdomen[1] has been twisted about, so as to be in a reversed position. There are seven exposed segments of the abdomen, which appears to come out from the lower and hinder quarter of the carapace but really (being inverted) from the upper postero-dorsal edge. From the imperfect preservation of some of the segments, the abdomen (16 mm. long) seems to be very slender near its origin, but higher at its ultimate segment (which is 7 mm. long). The proximal abdominal segments are only partly exposed; hence their narrowness is accidental and not a feature. The telson is 11 mm. long. One lateral spine (stylet), 7 mm., is present. The whole animal had a length of about two inches.

It was collected by the late Mr. Salwey in the Lower Ludlow at Leintwardine; and Mr. Salter at first labelled it as *Ceratiocaris inflatus*.

Fig. 3.—The probably true position of the carapace and abdomen in *Physocaris vesica*.

Pl. VII, figs. 8 *a*, 8 *b*. Carapace figured upside down; in olive-grey, micaceous sandstone, not calcareous; with scattered casts of small Brachiopods and Bivalves, as well as *Polyzoa*, *Beyrichia Kloedeni*, and other little fossils on a plane of

[1] The abdomen in Pl. XII, fig. 1, is also not only shifted but upside down.

bedding. There are also two fragments of abdominal segments of *Ceratiocaris;* one somewhat like Pl. III, fig. 4 *b*, and Pl. V, fig. 6 *b*. See Pl. IX, fig. 4.

A brown, much wrinkled film represents the carapace, which has been slightly broken or rather crushed in at the edge near one end, so that the exact outline there cannot be accurately defined.

Seven abdominal segments, striated across with delicate oblique lines (much like those on either half of fig. 10 *b*), and a style with one stylet, are attached to the carapace. These are drawn in fig. 8 *a* (as also formerly by Mr. Salter; see fig. 8 *b*) as if the appendages were in their normal position; but we think that the abdomen and spines have been twisted round and somewhat displaced since death. If they really retain their original relative position, the carapace had very unusual proportions in its dorsal and ventral curvatures. If, however, the abdomen and appendages have been inverted, the figs. 8 *a* and 8 *b* are upside down,—it is the right-hand and not the left-hand valve that is exposed,—the apiculate end should be on right hand of the observer,—and the slightly broken, hollow slope would be analogous to the antero-ventral ogee curve in such carapaces as fig. 6 on the same plate.

Fig. 8 *b* is a copy of Mr. Salter's woodcut figure of this specimen in the 'Ann. Mag. Nat. Hist.,' ser. 3, vol. v, 1860, p. 159. The figured beak-like process at the front end is not borne out by the specimen (fig. 8 *a*); and the narrow part of the abdomen is where it is still partly embedded. Mr. Salter observes that "this curious bladder-like species may very likely become the type of a new genus, in which case *Physocaris* would seem appropriate;" and he gives "*Cerat.* (*Physocaris*) *vesica*" as the title of his woodcut.

IV. Genus Emmelezoe, *T. R. J. & H. W.*, 1886.

Ceratiocaris, *M'Coy, Morris, Salter, Woodward.*
Ceratiocaris?, *T. R. J. & H. W.*
Emmelezoe, *T. R. J. & H. W.*

Ovate-oblong, boat-shaped carapace, striate and bearing an ocular tubercle.

1. Emmelezoe elliptica (*M'Coy*), 1849. Pl. VIII, figs. 1 *a*, 1 *b*.

1849.	Ceratiocaris ellipticus,		*M'Coy.*	Ann. Mag. Nat. Hist.,' ser. 2, vol. iv, p. 413.
1851.	—	—	—	Brit. Pal. Foss., fasc. i, p. 137, pl. 1 E, fig. 8.
1854.	—	—	*Morris.*	Catal. Brit. Foss., 2nd edit., p. 103.

1859.	Ceratiocaris	ellipticus,	*Salter.*	In Siluria, 2nd (3rd) edit., p. 538.
1860.	—	—	—	Ann. M. N. H., ser. 3, vol. v, p. 157.
1867.	—	—	—	In Siluria, 3rd (4th) edit., p. 516.
1873.	—	—	—	Catal. Camb. Sil. Foss., p. 178.
1877.	—	—	*H. Woodward.*	Catal. Brit. Foss. Crust., p. 71.
1885.	— ?	elliptica,	*T. R. J. & H. W.*	Third Report Foss. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886.	Emmelezoe	—	—	Fourth Report, p. 232; Geol. Mag., 1886, pp. 459, 460.

This interesting species, one of the first two established, is represented in the Cambridge Museum by specimen *b*/15 (the same as M'Coy's fig. 8 reversed). The carapace is elongate, sub-ovate or suboblong in outline, convex medially, with the greatest convexity of surface and curvature of ventral margin "at about one-third from the anterior end;" obliquely rounded in front; obliquely truncate at the upper portion of the hinder end, which rounds off from the ventral margin below, and slopes up to the blunt postero-dorsal angle above. The back is straight; the lower margin neatly curved. The valve measures 32 mm. long and 13 mm. high. There is a spot like a definite ocular tubercle in the anterior fourth and above the median line of each valve, and this gives it a distant likeness to a guinea-pig's profile. The spot is a small round tubercle, at about a sixth of the valve's length from the front, and a sixth of the height from the back. The surface is neatly marked with delicate, longitudinal, parallel lines, rather far apart. The figure of the specimen *b*/15, published in 1851, is reversed, and drawn too angular behind. It came from the Upper Ludlow sandstone of Benson Knot.

In 1860 Mr. Salter thought that *C. elliptica* was only a badly preserved variety of *C. inornata* ('A. M. N. H.' *l. c.*), but in the 'Catal. Cambr. Sil. Foss.,' p. 178, he recognised it as "quite distinct."

As intimated in our 'Third Report,' pp. 352, 353, the presence of the ocular tubercle has an important significance, showing that the animal must have had the organ equivalent to the eye sufficiently developed to affect the external covering, whether it was adapted for clear vision or not. It is not only a generic character distinguishing them from *Ceratiocaris*, but probably an important family distinction. At all events the oculate carapaces have to be removed from *Ceratiocaris*, and we have proposed that M'Coy's *C. elliptica* should be referred to a new genus under the name Emmelezoe.[1]

The above-described and three other specimens supply our only evidence of an eye-spot in these Ceratiocaridoid Phyllopods.[2]

[1] Ἐμμελής, elegant; ζωή, life (a termination common in some of M. Barrande's genera).

[2] The "ocular tubercles" mentioned in the footnote at p. 236, 'Siluria,' 3rd (4th) edit., 1867, are without doubt due to the presence of "teeth" within the valves.

Pl. VIII, figs. 1 *a*, 1 *b*. This is specimen *b*/15 in the Cambridge Museum; marked "*Ceratiocaris ellipticus*, M'Coy, 'Brit. Pal. Foss,' pl. 1 E, fig. 8." It is in a dark-grey, micaceous, fine-grained, slightly calcareous sandstone of the Upper Ludlow formation; Benson Knot, Kendal.

2. Emmelezoe crassistriata, *T. R. J. & H. W.*, 1886. Pl. VIII, figs. 3 *a*, 3 *b*.

1878. Ceratiocaris Murchisoni, *Huxley, Newton, & Etheridge.* Catal. Foss. M. P. G., p. 142.
1885. — elliptica, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886. Emmelezoe crassistriata, — Fourth Report, p. 233; Geol. Mag., 1885, p. 460.

Carapace subovate; somewhat compressed, but rather convex above the median line; imperfect at the ends, but probably once bluntly pointed in front and rather above the middle line behind; back gently convex; ventral border deeply and nearly symmetrically curved. Two peculiar little round spots are present just below the middle on the ventral edge.[1] Strongly striate with parallel, longitudinal, anastomosing wrinklets, wide apart and somewhat interrupted. Ocular spot a distinct, round tubercle at one-fourth of the length of the valve from the front and one-fourth height from the back; and somewhat worn. An accidental depression occurs behind the eye-spot. The valve in profile is somewhat like the head of a Chætodon.

Mus. Pract. Geol. x $\frac{1}{10}$, Pl. VIII, figs. 3 *a*, 3 *b*, is preserved in a greenish-grey, micaceous, and somewhat calcareous Upper Ludlow sandstone, from Combe Wood, Presteign. This is larger than either *E. elliptica* or *E. tenuistriata*, and being coarsely striated has been named by us E. crassistriata.

3. Emmelezoe tenuistriata, *T. R. J. & H. W.*, 1886. Pl. VII, figs. 9 *a*, 9 *b*.

1885. Ceratiocaris elliptica, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886. Emmelezoe tenuistriata, — Fourth Report, p. 232; Geol. Mag., 1885, p. 460.

The specimen Ludlow Museum G, Pl. VII, fig. 9, is shorter and broader

[1] Two somewhat analogous spots, but further apart, are seen on the ventral margin of *Leperditia grandis*.

(higher) than *Em. Maccoyiana;* though imperfect, it seems to have been nearly semicircular in outline below with an acute and projecting postero-dorsal angle; and its surface has a fine, almost silky, linear ornament. As a new species we have called this E. TENUISTRIATA. No locality is noted; but it is probably from the Lower Ludlow series near Ludlow, in the usual greenish-grey mudstone, slightly calcareous, with a fragment of *Graptolithus priodon*. The carapace-valve is elliptical in shape, slightly arched on the back, deeply and nearly symmetrically curved below; the postero-dorsal angle is above the median line and strong. The antero-dorsal region is embedded in the matrix. The valve, brown, thin, and filmy or membrane-like, is much flattened by pressure; it is ornamented with very delicate longitudinal striæ, magnified in fig. 9, *b* (placed vertically instead of horizontally on the plate). A morsel of the browner and more solid test is visible at the antero-ventral margin; also at the broken edge of the specimen where the compressed contents of the carapace are seen to constitute a definite layer overresting upon the opposite (embedded) valve.

In the antero-dorsal region is a small, round, raised *ocular spot*. Lower down and more behind is a rough cavity with an irregular raised rim, caused by the presence of internal organs.

4. EMMELEZOE MACCOYIANA, *T. R. J. & H. W.*, 1886. Pl. VIII, figs. 2 *a*, 2 *b*.

1878. CERATIOCARIS MURCHISONI, *Huxley, Newton, & Etheridge.* Catal. Foss. M. P. G., p. 118.
1885. — ELLIPTICA, *T. R. J. & H. W.* Third Report Pal. Phyll., p. 352; Geol. Mag., 1885, p. 466.
1886. EMMELEZOE MACCOYIANA, — Fourth Report, p. 233; Geol. Mag., 1886, p. 460.

Carapace-valve boat-shaped, narrow-elliptical, smooth, longitudinally striate, with the lines rather wide apart. In general character like Pl. VIII, fig. 3, but smaller and much narrower in proportion. Much flattened by pressure. Not so large as in fig. 1, and differing from it in both anterior and posterior outlines.

This specimen, M. P. G. $\frac{2\,3}{3\,2}$, smaller than either *E. elliptica* or *E. crassistriata*, is somewhat boat-shaped, and between the two above-mentioned in shape but not identical with either; and it is rather coarsely striated longitudinally. To this form we have given the name E. MACCOYIANA in honour of the first describer of any member of the genus.

The specimen is from Leintwardine (Lower Ludlow), in brownish-grey, micaceous mudstone, calcareous along thin streaks at the edge.

LIST OF THE PALÆOZOIC PHYLLOCARIDA DESCRIBED IN THIS MONOGRAPH: PART I.

	Carbouiferous Limestone; Oreton.	Ludlow Beds.				Wenlock Beds.		Upper Llandovery; Onny River.	Tremadoc Slates; Portmadoc.
		Upper Ludlow; Ludlow.	Upper Ludlow; Benson Knot, Kendal.	Upper Ludlow; Lesmahago, or Muirkirk.	Lower Ludlow; at and near Ludlow.	Dudley, Welshpool, or Kirkby-Lonsdale, &c.	Lower Wenlock; Helm Knot, Dent.		
1. Ceratiocaris leptodactylus	...	...	...	...	×	...	×		
2. — Murchisoni	...	×	...	...	×	×			
3. — valida	...	..	...	...	...	×			
4. — tyrannus	...	...	...	...	×				
5. — gigas	...	...	...	..	× & Knighton	×			
6. — Halliana	...	...	...	...	×				
7. — Pardoëana	...	...	...	...	×				
8. — canaliculata	...	×							
9. — Ludensis	...	...	...	...	×				
10. — papilio	...	...	×	×	×				
11. — stygia	...	...	×	×	×				
12. — longa	...	?	...	...	×				
13. — robusta	...	...	...	×	×				
14. — patula	...	...	...	...	×				
15. — angusta	...	...	...	×					
16. — minuta	...	...	...	...	×				
17. — inornata	...	...	×	×					
18. — Ruthveniana	...	...	×						
19. — Oretonensis	×								
20. — truncata	×								
21. — solenoides	...	...	×						
22. — gobiiformis	...	...	×						
23. — Salteriana	...	...	...	...	× & Dudley				
24. — laxa	...	...	...	×					
25. — compta	...	...	...	...	×				
26. — cassia	...	...	...	...	×				
27. — cassioides	...	...	...	...	×				
28. — ? longicauda (D. Sharpe). Lower Silurian; Portugal.									
29. — ? decora	...	× & Malvern	...	...	?				
30. — ? lata	...	...	...	...	...	...	...	...	×
31. — ? insperata	...	...	...	...	...	...	...	...	×
32. — ? sp.	...	...	...	...	...	...	...	×	
33. — perornata	...	...	×						
34. Xiphocaris ensis	...	...	...	...	×				
35. Physocaris vesica	...	...	...	...	×				
36. Emmelezoe elliptica	...	...	×						
37. — crassistriata	...	Presteign							
38. — Maccoyiana	...	...	...	...	×				
39. — tenuistriata	...	...	...	...	×				

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1892.

LONDON:
MDCCCXCII.

A MONOGRAPH

OF THE

BRITISH PALÆOZOIC PHYLLOPODA

(PHYLLOCARIDA, Packard).

BY

PROF. T. RUPERT JONES, F.R.S., F.G.S., &c.,

AND

DR. HENRY WOODWARD, F.R.S., F.G.S., &c.

PART II.

SOME BIVALVED AND UNIVALVED SPECIES.

Pages 73—124; Plates XIII—XVII.

With Addenda and Corrigenda to Part I.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1892.

PRINTED BY
ADLARD AND SON, BARTHOLOMEW CLOSE

PART II.

The Table given at pages 2 and 3 of Part I (1888) indicates that bivalved forms with the carapace-valves more or less easily separable, and either pod-shaped or conchiferoid, come near to *Ceratiocaris* lately described in that Part. Some of these we shall deal with presently. There is one form, however, having a folded shield, like that of *Nebalia*, which has the lateral halves of the carapace and the exserted abdominal segments so much like those features in *Ceratiocaris* that it seems advisable to take it (*Hymenocaris*) into consideration at once. We may here remark that, with regard to the two associates of *Hymenocaris* in the Table at page 2, we have not yet obtained any further information about Barrande's "*Cytheropsis testis*;"[1] and that *Proricaris* (wrongly referred to this group as *Protocaris*) is not a Phyllopod, but had been conjecturally made up of portions of the limbs of *Eurypterus* or *Pterygotus*. (See 'Report Brit. Assoc.' for 1889 (1890), p. 68.)

It will be convenient to take up in succession to *Hymenocaris* those forms (*Lingulocaris*, &c.) resembling the shells of some bivalve molluscs, and then the little pod-like *Caryocaris*, which is probably not far removed zoologically from *Ceratiocaris*. Subsequently those with flat sutured carapaces (*Aptychopsis*, *Peltocaris*, and *Pinnocaris*) will be described, and then such as have flat entire carapaces (*Discinocaris*); and, lastly, the Apus-like forms (*Dithyrocaris*).

A. *Phyllopodous Forms with Hinged or Folded Valve-like Carapaces.*

V. *Genus*—Hymenocaris, *Salter*, 1853.

Salter, 'Report British Assoc.' for 1852 (1853), Transact. Sect., pp. 56—58.
Morris, 'Catal. Brit. Foss.,' 1854, p. 109.
H. Woodward and Salter, 'Catal. and Chart Foss. Crust.,' 1865, p. 17.
Salter, 'Memoirs Geol. Survey Great Britain, &c.,' vol. iii, 1866, p. 293; 2nd edit., 1881, p. 484.

[1] The form quoted as such by MM. de Tromelin and Lebesconte in 1875 is not the same (see Dr. C. Barrois's "Mémoire sur la Faune du Grès Armoricain," 'Annales Soc. Géol. du Nord,' vol. xix, 1891, pp. 147 and 149).

H. Woodward, 'Catal. Brit. Foss. Crust.,' 1877, p. 75.

T. R. Jones and H. Woodward, 'Report Brit. Assoc.' for 1883 (1884), p. 217; 'Monogr. Brit. Palæozoic Phyllop.,' Pal. Soc., pt. 1, 1888, p. 2.

Etheridge, 'Foss. Brit.,' vol. i, Palæozoic, 1888, p. 55.

Woods, 'Catal. Type Fossils Woodw. Mus. Cambridge,' 1891, p. 136.

This Palæozoic Phyllopod was first noticed and named by Mr. J. W. Salter. It is a somewhat shrimp-like form, allied to the living *Nebalia* and the Silurian *Ceratiocaris*. The carapace is simply bent on the back, so as to form two subtriangular lateral flaps or attached valves. Several (eight or nine) abdominal segments are exposed, ending with six delicate, tapering caudal appendages. Its generic characters are recognised in a detailed description of its one best-known species.

1. Hymenocaris vermicauda, *Salter*. Plate XIII, figs. 1—14.

Hymenocaris vermicauda,		*Salter*.	Report Brit. Assoc. for 1852 (1853), p. 58.
—	—	*Morris*.	Catal. Brit. Foss., 2nd edit., 1854, p. 109.
—	—	*Salter*.	In Murchison's Siluria, 1st edit., 1854, p. 42, foss. 3; 3rd edit. (including Sil. Syst.), 1859, p. 45, foss. 5, fig. 1; 4th edit. (including Sil. Syst.), 1867, p. 44, foss. 6, fig. 1.
—	—	*Woodward and Salter*.	Catal. and Chart Foss. Crust., 1865, p. 17, fig. 1.
—	—	*Salter*.	Mem. Geol. Survey Great Brit., vol. iii, 1866, p. 293, pl. ii, figs. 1—4 (the last is a restoration); pl. v, fig. 25; 2nd edit., 1881, p. 484, the same figs.
—	—	*Baily*.	Figures Charact. Brit. Fossils, 1867, p. 8, pl. iv, figs. 1 *a*, 1 *b* (restoration).
—	—	*Bigsby*.	Thesaurus Siluricus, 1868, p. 75.
—	—	*Salter*.	Catal. Camb. Silur. Foss. Cambridge, 1873, p. 10, woodcut (restoration).
—	—	*H. Woodward*.	Cat. Brit. Foss. Crust., 1877, p. 76.
—	—	*Huxley, Newton, and Etheridge*.	Catal. Cambr. Sil. Foss. Mus. Pract. Geol., 1878, pp. 7, 10.
—	—	*T. R. Jones*.	Geol. Mag., 1883, p. 463.
	—	*T. R. Jones and H. Woodward*.	Report[1] Brit. Assoc. for 1883 (1884), p. 217; ibid.[2] for 1888 (1889), p. 178, figs. 2—5.
—	—	*Etheridge*.	Foss. Brit., vol. i, Palæoz., 1888, p. 55.
—	—	*Woods*.	Catal. Type Fossils Cambridge, 1891, p. 136.

[1] The First Report of the Committee, consisting of Mr. R. Etheridge, Dr. H. Woodward, and Professor T. Rupert Jones (Secretary), on the Fossil Phyllopoda of the Palæozoic Rocks.

[2] The Sixth Report.

Hymenocaris vermicauda has its carapace folded or bent along the back, so as to form an overarching carapace (as in *Nebalia*) with two symmetrical, suboval, valve-like sides, somewhat resembling saddle-flaps, not so deep in front as behind, obliquely rounded or semi-elliptical below, and with a very slightly convex dorsal line.[1] The curvature of the ventral edge varies in fulness and in obliquity with individuals, and is nearly always modified by the pressure to which the shale or mudstone containing the fossils has been subjected. The specimens are all flattened laterally; some are lengthened, and some shortened, according to their position relative to the direction of the squeeze; and nearly all are crumpled or "plaited"[2] with parallel foldings, coarse or fine, at right angles to the line of pressure.

Some of the best preserved individuals measure $\frac{9}{10}$ inch (21 mm.), others 1 inch (23 mm.), and others (imperfect otherwise) even more, along the back line. Those with the first two measurements are $\frac{8}{10}$ inch (19 mm.) in height; and their angular length (from antero-dorsal to postero-ventral point) is $1\frac{3}{10}$ inches (56 mm.). Many smaller individuals occur.

The carapace was thin (hence the name = "membranous") and apparently smooth. No definite structure has been observed, but Salter noted "short wavy lines" on the carapace and the abdominal segments ('Mem. Geol. Survey,' vol. iii, p. 294), and a marginal furrow along the posterior border of the valves (p. 293).

Owing to the compressed and plaited condition of the schistose matrix, it is difficult to define the original outline of the ends of the carapace. The fig. 4 in pl. ii, 'Mem. Geol. Surv.,' vol. iii, is a restoration, and its truncate anterior end is a very doubtful feature. The outline given of a specimen shown in fig. 3 (loc. cit.) is not supported by the specimen itself.[3] The front angle, though often modified or suppressed by the imperfect cleavage of the squeezed mudstone, is sometimes perfect enough to show that it was much sharper than in the fig. 4 referred to above, in which the truncation is probably due to fracture of one of the specimens used in making this restoration of the animal. The posterior margin appears to have sloped downwards and outwards, with a bold ventral curve, but usually without the sinuous (ogee) bend under the dorsal angle which *Ceratiocaris* generally exhibits.

The relative position of carapace and body-segments has been subjected to much interference, between the death and the imbedment of the specimens, from the decomposition of the soft parts or connecting tissues and the shifting of the

[1] Much like the carapace-valves of *Ceratiocaris Pardoëana* in shape (Monogr., part i, 1888, pl. v, figs. 1 and 2.

[2] Salter, 'Quart. Journ. Geol. Soc.,' vol. x, 1854, p. 209; and 'Mem. Geol. Surv.,' iii, 1866, p. 247, note.

[3] The two small spikes figured in the same illustration are illusory, as are also the three needle-like projections in the woodcut in 'Siluria,' 1854, 1859, and 1867, though often copied in text-books.

harder covering; yet Mr. Salter's determination of the more truncate or wider (higher) end of the carapace being the hinder margin seems to be well founded, whether the abdomen be still in apposition or not.

The crumpled bed-planes of the hard shale or flagstone frequently exhibit crushed body-joints of the *Hymenocaris;* but these relics of the abdominal portion vary much in the number of attached segments. Sometimes four or five, but not uncommonly six or seven body-joints occur, with or without the telson being apparent. Eight or nine together are less frequent. In one instance (in the Owens College Museum) ten or eleven segments can be counted, besides an obscure telson, in an unattached body (Pl. XIII, fig. 10) lying on a slab containing numerous specimens of carapaces and body-rings of *Hymenocaris* (from Garegfelen, collected and given by Mr. D. Homfray). In this case some (five or six) segments, which appear to have been softer than the others, may have been within the carapace, for they differ from the others in size and distinctness of outline.

The crushing and squeeze have rendered even the best and most promising specimens so obscure that much doubt still exists in the observations on this Phyllopod. Mr. Salter determined nine exposed body-rings ('Mem. Geol. Surv.,' vol. iii, p. 293, but only eight are shown in his pl. ii, fig. 4), with one pair of styles and two pairs of stylets attached to the last joint (op. cit., pl. v, fig. 2). The abdominal joints vary from about $\frac{3}{10}$ to $\frac{4}{10}$ inch (7 to 9 mm.) in height, sometimes to $\frac{5}{10}$ (12 mm.), very rarely to $\frac{6}{10}$ and $\frac{7}{10}$ (15 and $17\frac{1}{2}$ mm.), but in one case to $\frac{8}{10}$ inch (20 mm.), according to size of individuals and the accidental crush.

The caudal appendages consist of six setæ, springing from the terminal edge of the last body-segment or telson, and arranged in three pairs, namely, a central pair, 5·75 mm. long, and two outside pairs, each of which has its inner spine or seta, 8 mm. long, and its outer spinule, 3·17 mm. long (see Pl. XIII, fig. 9, magnified).

In his "Monograph of the Phyllopod Crustacea of North America" ('Twelfth Annual Report of the U.S. Geol. Survey,' 1883), Dr. A. S. Packard figured and described (pp. 437, 536, and 590, pl. xxxvi, fig. 7, and pl. xxxvii, fig. 5) the cercopods of *Nebalia*. An embryonic *N. Geoffroyi* has two strong tapering cercopods, each terminating with a long seta between two short spinose setæ. If the two cercopods were reduced and united laterally, the six setæ would be brought together, and represent the three paired (or doubly trifid) cercopods of *Hymenocaris*. In other words, *Hymenocaris* has caudal appendages equivalent to the terminal setæ of the *Nebalia* referred to if these latter were brought together laterally, and stood out directly from the last body-segment or telson without any differentiated basal cercopods.

Hymenocaris vermicauda occurs in the Lower Lingula-flags, especially "in the upper portions of the true Lingula-flags" (Salter, *op. cit.*, p. 293, and 'Catal. Pal. Foss. Cambridge Mus.,' p. 10), near Tremadoc, Ffestiniog, and Dolgelly. The particular localities[1] are the railway-cutting near Wern, not far from Penmorfa; Pentre'r-felin, west of Penmorfa; Gareg-felen; Bryntwr Summerhouse; and especially the hill descending to Penmorfa Church; Moel-y-gest, the hill behind Portmadoc; Borth cove or harbour, near Portmadoc; also at Ffestiniog; Gwern-y-barcud ('Mem. Geol. Surv.,' vol. iii, p. 294), Moel-hafod-Owen, and other places near Dolgelly; and doubtfully at Pont Seiont, Caernarvon. A specimen in the British Museum is from the 'Upper Tremadoc' schistose shale of Garth, near Portmadoc. The Halifax Museum also possesses one or more specimens from the "Upper Tremadoc flags" of Garth, Portmadoc.

The rippled flagstones of the Lingula series near Tremadoc, at the village of Y-Felin-newydd, and near Pentre'r-felin and Wern, on the Criccieth road, are marked with tracks referred, with good reason, by Mr. Salter to *Hymenocaris vermicauda* ('Quart. Journ. Geol. Soc.,' vol. x, 1854, pp. 208—211; and 'Mem. Geol. Surv.,' vol. iii, p. 248 and p. 294, pl. i).

§ 1. Carapaces.

The chief specimens which we have met with and regarded as illustrative of this species are the following:

1. A large specimen (Pl. XIII, fig. 1) wanting the caudal extremity. Both the carapace and the eight abdominal segments have been obliquely squeezed from above and behind towards the infero-anterior region; and the left-hand carapace-valve here shown is, in particular, somewhat lengthened backwards and downwards.

This occurs in dark-grey slaty mudstone, minutely micaceous, from the Middle Lingula-flags, at Borth, Portmadoc. In the Cambridge Museum ($\frac{A}{1061}\ \frac{b}{286}$).

It is referred to in the 'Report on British Palæozoic Phyllopoda' for 1888 (1889), p. 178, fig. 4.

This is very similar to the specimen figured by Salter in the 'Mem. Geol. Surv.,' vol. iii, 1866, pl. ii, fig. 1, which is in the Museum of Practical Geology, and which lies in dark-grey schistose mudstone from Penmorfa, near Tremadoc.

2. Carapace and abdomen of a large individual (Pl. XIII, fig. 12). Both are imperfect and much compressed. The two valves are indistinctly indicated; the

[1] Mr. David Homfray, who collected the larger portion of the known specimens of this genus, has favoured us with a note of the localities.

abdomen retains some trace of caudal spines, but has probably been turned upside down.

In bluish-grey shaly flagstones with rusty facings. From the Lingula-flags at Borth, Portmadoc. Cambridge Museum ($\frac{A}{171}$ $\frac{a}{15}$).

3. A distorted and somewhat crushed, but otherwise nearly perfect individual (Pl. XIII, fig. 2). The abdominal segments (eight well shown with a trace of another) are turned up behind at a sharp angle with the carapace; and the last segment retains some portions of the caudal appendages.

In bluish-grey flagstone with rusty facings. Middle Lingula-flags; Borth, Portmadoc. British Museum, I 322. D. H.

4. The broken front part of a valve, with eight segments (and trace of a ninth) lying at an angle with it, and retaining portions of the tail-spines. Pl. XIII, fig. 3.

In bluish-grey slaty flagstone with rusty facings. Portmadoc. British Museum, I 322. D. H.

5. Carapace or left-hand valve, lying separate from seven body-segments, not perfect, but retaining a remnant of one of the caudal spines. Pl. XIII, fig. 4.

In dark grey slaty mudstone, minutely micaceous. Middle Lingula-flags; Borth, Portmadoc. In the Cambridge Museum ($\frac{A}{161}$ $\frac{b}{286}$).

Referred to in the 'Report Brit. Assoc.' for 1888 (1889), p. 178, fig. 3.

6. A small specimen (Pl. XIII, fig. 5), showing the right-hand side of a carapace having a bold posterior ogee curve that has been increased by pressure. Also eight body-segments, turned downwards at right angles, and retaining the full number of cercopods, namely, a small central pair, flanked on each side by one large and one small spine. Of these appendages the middle pair are rather shorter than those in fig. 9 (magnified $2\frac{1}{2}$ diameters), but the outer pairs are of about the same length.

In dark-grey slaty mudstone. Middle Lingula-flags; Borth. Cambridge Museum ($\frac{A}{161}$ $\frac{b}{287}$. D. H.).

Referred to in 'Report Brit. Assoc.' for 1888 (1889), p. 178, fig. 5.

7. A large carapace, or left-hand valve (Pl. XIII, fig. 13), modified by pressure, and widened into an irregular lozenge shape.

In dark-grey schistose mudstone. Lingula-flags; Portmadoc. Museum Practical Geology, marked $\frac{1}{29}$; Wyatt-Edgell Coll. 'Catal. Camb. Sil. Foss.,' 1878, p. 10.

8. Distorted valve, narrowed by pressure, and imperfect by fracture at the lower part of the posterior edge. Pl. XIII, fig. 6. In contrast with fig. 13. Referred to in the 'Report British Assoc.' for 1888 (1889), p. 178, fig. 2.

In dark-grey slaty flagstone, very minutely micaceous, much squeezed. From the Ffestiniog group; Borth, Portmadoc.

Cambridge Museum ($\frac{A}{173}$).

§ 2. Body-segments.

9. Eight body-segments, of large size, without caudal appendages (Pl. XIII, fig. 7). Much compressed, thereby having greater height than originally. In bluish-grey slaty flagstone with rusty facing, squeezed. Lingula-flags; Cae'n-y-coed, near Maentwrog.

Cambridge Museum ($\frac{A}{174}$ $\frac{B}{297}$. D. H.).

Referred to in 'Report Brit. Assoc.' for 1883 (1884), p. 221.

10. Five body-segments, with portions of the tail-spines on the last (Pl. XIII, fig. 14), somewhat crumpled by oblique pressure. In light bluish-grey schistose mudstone with rusty facings. Borth, Portmadoc.

British Museum, I 322.

11. Six (?) body-segments, with remnants of the tail-spines (Pl. XIII, fig. 8). In dark-grey slaty mudstone, minutely micaceous, squeezed. Portmadoc.

Museum Pract. Geol., marked $\frac{1}{29}$; Wyatt-Edgell Coll. 'Catal. Cambr. Sil. Foss.,' 1878, p. 10.

12. The last three body-segments, with the six caudal appendages well exhibited (Pl. XIII, fig. 9). Magnified $2\frac{1}{2}$ diameters. This is the same specimen as that figured in the 'Mem. Geol. Surv.,' vol. iii, pl. v, fig. 25. In dark-grey slaty mudstone, Lower Lingula-flags; Moel-y-gest, Tremadoc.

13. Two groups of narrow body-segments, separate from their carapaces. Pl. XIII, fig. 10 shows eleven (?) joints, five or six of which seem to have been soft, round, and indistinct, whilst five or six were harder, more angular, distinct, and terminated with caudal spines. Fig. 11 shows 15 (?) segments, separated, distorted, and possibly not all belonging to one and the same animal. In dark-grey slaty mudstone with Linguläe, squeezed. Lingula-flags; Gareg-felen, D. H. The Owens College, Manchester.

The gradation in size of the abdominal segments from fig. 7 to figs. 1, 12, 2, 3, 14, and 4, and to figs. 5, 8, 10, 11, and 9 ($\times$ $2\frac{1}{2}$), may be accounted for by relative age alone.

2. Hymenocaris ? lata, *Salter*, 1866. Fig. 4 (woodcut).

Hymenocaris ? latus,		*Salter*.	Mem. Geol. Surv., vol. iii, 1866, p. 240 (in list).
Ceratiocaris ? latus,		*Salter*.	Ibid., p. 294, woodcut 5; 2nd edit., 1881, p. 486, woodcut 5.
—	—	*Salter*.	In Siluria, 1867, p. 516.
—	—	*Salter*.	Catal. Cambr. Silur. Foss., 1873, p. 16.
—	—	*H. Woodward*.	Catal. Brit. Foss. Crust., 1877, p. 71.
—	—	*T. R. J. and H. W.*	Geol. Mag., 1885, p. 465.
—	—	—	Ibid., 1886, p. 460.

CERATIOCARIS ? LATUS, *T. R. J. and H. W.* Report Brit. Assoc. for 1885 (1886), p. 351.
— — — Monogr. Brit. Palæoz. Phyll., part i, 1888, p. 63.
— — *Woods.* Catal. Type Foss. Camb. Mus., 1891, p. 134.

Mr. Salter's figure referred to above is a restoration of five (?) body-segments, which apparently had been embedded in an oblique position and crushed endwise so as to be widened and shortened, with a subspiral outline, 28 mm. broad by 12 mm. high (the restoration gives 22 by 15 mm.). See Fig. 4 (woodcut).

The direction of pressure must have been at right angles to the minute plaiting of the matrix, obliquely crossing the compressed remains of the animal, and therefore not quite coincident with the long axis of the original individual.

FIG. 4. — *Hymenocaris lata*, Salter. Some obliquely squeezed abdominal segments. From Garth.

These segments are probably not too broad for some such individual as that to which fig. 7 of our Pl. XIII belonged; but they are so narrow in their longitudinal succession, though with great apparent breadth, and Salter's restoration makes them taper so rapidly, that we may conveniently keep the specific name given by Salter, though we prefer to adopt his first suggestion (in the list at p. 240, op. cit.) that it was referable to *Hymenocaris*.

In dark-grey flagstone, Upper Tremadoc group; Garth, Portmadoc. Cambridge Museum.

VI. *Genus*—LINGULOCARIS, *Salter*, 1866.

SALTER, 'Mem. Geol. Survey,' vol. iii, 1866, pp. 252 and 294; 2nd edit., 1881, p. 485.
H. WOODWARD, 'Catal. Brit. Foss. Crust.,' 1877, p. 76.
T. R. JONES, 'Geol. Mag.,' 1883, p. 463.
T. R. JONES and H. WOODWARD, 'Report Brit. Assoc.' for 1883 (1884), pp. 217 and 223.
ETHERIDGE, 'Foss. Brit.,' vol. i, Palæoz., 1888, p. 58.

This was determined and described as a Palæozoic bivalved Phyllopod, from the Upper Tremadoc slates of Tu-hwnt-i'r-bwlch, Garth, Portmadoc, North Wales, by Mr. J. W. Salter, in the 'Memoirs of the Geological Survey,' vol. iii, 1866, pp. 253 and 294. His description of the generic characters is as follows:—"A thin bivalve crustacean shell, with a generic form like that of a *Modiola* or *Mytilus*, with scarcely prominent beaks, and *no?* hinge-teeth; the surface of the carapace is covered by fine, raised, concentric lines."

1. Lingulocaris lingulæcomes, *Salter*, 1866. Plate XIV, fig. 4 (?).

Lingulocaris lingulæcomes, *Salter*.			Mem. Geol. Survey (Appendix to Ramsay's Geol. North Wales), vol. iii (1866), pp. 253 and 294, pl. x, figs. 1 and 2; and 2nd edit. of Ramsay's Geol. North Wales, 1881, p. 485, pl. x, figs. 1, 2.
—	—	—	Catal. Cambr. Silur. Foss. Cambridge, 1873, p. 16, woodcut.
—	—	*Bigsby.*	Thesaur. Silur., 1868, p. 76.
—	—	*H. W.*	Cat. Brit. Foss. Crust., 1877, p. 76.
—	—	*H., N., and E.*	Cat. Cambr. Foss. Mus. Pract. Geol., 1878, p. 15 ($\frac{2}{5}$).
—	—	*T. R. J. and H. W.*	Rep. Brit. Assoc. for 1883 (1884), p. 223.
—	—	*Etheridge.*	Foss. Brit., vol. i, Palæoz., 1888, p. 58.
—	—	*Woods.*	Catal. Type Foss. Cambridge, 1891, p. 136.

In the Woodwardian Museum at Cambridge are two specimens of a bivalve ($\frac{A}{273}$), there labelled "*Mytilocaris lingulæcomes*, Salter," from the Upper Tremadoc slates, Garth, Portmadoc, one of which, seemingly representing the outside, but somewhat crumpled longitudinally, approximates in its outline and size ($1\frac{3}{10} \times \frac{1}{2}$ inch $= 32 \times 12$ mm.) to Mr. Salter's restoration (?), fig. 1, pl. x, and woodcut in 'Cat. Cambridge Foss.,' p. 16. The other is a less perfect internal cast. Otherwise we have not met with any corresponding specimen; in the Museum of Practical Geology, however, there is an imperfect internal cast showing the dorsal aspect, somewhat deformed by pressure, of a bivalved form (Pl. XIV, fig. 4), which may possibly belong to *L. lingulæcomes* or an allied form, referred to in the 'Catal. M. P. G. Mus. Cambr. Sil. Fossils,' 1878, p. 28, as "Bivalve Crustacean." It is marked $D\frac{4}{19}$. From the Upper Llandeilo, near Builth; in dark flagstone minutely micaceous.

In the Halifax Museum are specimens of this species from the Upper Tremadoc flags at Portmadoc.

An imperfect specimen in schistose mudstone from the Upper Tremadoc series at Garth, Portmadoc, in the Museum of Practical Geology, much crushed, marked $\frac{2}{4}$, as well as six rather small, crushed, and distorted specimens ($\frac{2}{5}$) are referred to *L. lingulæcomes* at p. 15, 'Catal. Cambr. and Silur. Foss. M. P. G.,' 1878.

2. Lingulocaris siliquiformis, *Jones*, 1883. Plate XIV, figs. 1 and 2.

Lingulocaris lingulæcomes, *Huxley, Newton, and Etheridge.* Catal. Cambr. Silur. Foss. Mus. Pract. Geol., 1878, p. 15 ($\frac{3}{4}$).

Lingulocaris siliquiformis, *T. R. Jones.* Geol. Mag., 1883, p. 464.
— — *T. R. Jones and H. Woodward.* Report Brit. Assoc. for 1883 (1884), pp. 215 and 223; ibid. for 1888 (1889), p. 177, figs. 8 and 9.

In the British Museum are casts of the insides of two bivalves ("48654" and "I, 2590") labelled "*Lingulocaris;*" but, though probably belonging to Mr. Salter's genus here mentioned, they differ much from its first species in outline. They are longer, sharper at one end, and more nearly resembling a pea-pod in shape. This species we have distinguished as *L. siliquiformis.*

At p. 223 of the First Report (1883) we described this Cambrian Phyllocarid as differing from Salter's *L. lingulæcomes,* as above. One specimen (Pl. XIV, fig. 1), rather wrinkled by crush, in bluish-grey slaty mudstone, with rusty facings, from the Upper Tremadoc series at Garth Hill, Portmadoc, was presented to the British Museum by the Rev. J. F. Blake (No. I, 2590). Another (fig. 2), in grey slaty micaceous mudstone, also in the British Museum, is marked "48654 from the schistose Bala rock at Bwlch-y-gaseg, near Cynwyd, Corwen; J. P., March 14th, 1868."

3. Lingulocaris Salteriana, *T. R. J. and H. W.*, 1889. Plate XIV, fig. 3.

Lingulocaris Salteriana, *T. R. Jones and H. Woodward.* Report Brit. Assoc. for 1888 (1889), pp. 176 and 177, figs. 6 and 7.

The British Museum has a fine specimen of one of the old Cambrian Phyllocarids from the Tremadoc-slate series (No. I, 2591). It is a black, shining, and filmy valve (or compressed bivalved carapace), seen as an impression and counterpart on a split slab of hard, dark-grey, micaceous mudstone, which has been subjected to the usual lateral pressure. The valve, $3\frac{1}{4}$? $\times$ $1\frac{1}{8}$ inches (83 by 28 mm.), is acutely subovate or sharply boat-shaped in outline, convex below and straight above, and was acute probably at each end, though one of them is damaged. It retains a remnant of one of the small, subtriangular, terminal extensions of the dorsal edge, such as are present in *L. siliquiformis.* See fig. 6 in our Sixth Report, for 1888, p. 178.

The surface is peculiarly marked with what seem to be modifications of ornamental striæ or linear plaits, namely, very small lenticular and bead-like elevations, which may have resulted from raised longitudinal striæ being crossed by the delicate plaiting of lateral pressure at slightly different angles.

We dedicated this fine species to the memory of our friend Mr. J. W. Salter,

whose labours in elucidating these old Phyllopodous forms are well known. It was found by Dr. R. Roberts in the Tu-hwnt-i'r-bwlch quarry at Portmadoc, with *Asaphus*.

Another of the old associates of *Hymenocaris* in the Tremadoc series is the "second specimen" mentioned at p. 220 of our First Report (1883). Though smaller than the foregoing ($2\frac{6}{8} \times \frac{13}{16}$ inches, 70 by 21 mm.), it is of a somewhat similar shape, having been acute at both ends (probably, though one is broken), elliptically curved below and nearly straight above, thus having the outline of a sharp-ended boat (fig. 7 in our Sixth Report (for 1888), p. 179). It is not really "emarginate" at one end, as stated at p. 220 of the First Report, that appearance being due to a slight transverse crack and some inequality of the surface near the end, which was probably acute, but has been squeezed out of shape and frayed away by the longitudinal plaiting of the hard, compressed, slaty shale or mudstone. The cross-pressure has also coarsely plaited the valve throughout, and somewhat lengthened it.

From the upper part of the Lower Lingula-flags at Cae'n-y-coed, near Maentwrog. Coll. Mr. D. Homfray. Woodwardian Museum, Cambridge ($\frac{A}{160}$).

A somewhat similar but badly preserved fossil, from the Brathay Flags of Long Sleddale (Marr Coll. in the Cambridge Museum), is probably a *Lingulocaris* of the same or a closely allied species ('Catal. Type Foss. Camb. Mus.,' 1891, p. 136).

4. Lingulocaris, sp. Plate XIV, figs. 5 *a*, 5 *b*.

'Report. Brit. Assoc.' for 1889 (1890), p. 65.

An interesting specimen in M. Lebesconte's collection (at Angers) from the 'Schiste ardoisier inférieur (Faune 2de)' of Angers (Maine et Loire), very closely resembles *Lingulocaris Salteriana*, J. and W., shown by fig. 6, at p. 179 of our Sixth Report (for 1888), and in Pl. XIV, figs. 1 and 2. Unfortunately it is badly preserved and not quite perfect.

It was probably about 80 mm. long when perfect; it is 21 mm. broad (high) where widest, at a third of its length from one end, which, if it be the anterior, is more acute than in *L. siliquiformis*. The dorsal line was gently convex, and the ventral was much fuller, with a somewhat angular convexity. Fig. 5 *b* shows the sectional area at the widest part; its contours may have been modified by pressure. Much of the surface of the cast is thickly dotted over with possible indications of spinules or small tubercles.

VII. *Genus*—Saccocaris, *Salter*, 1868.

'Proceed. Geol. Polytech. Soc. W. R. Yorkshire,' vol. iv, 1868, pp. 588, 589.

In 1867 Mr. Salter noticed a relatively large oblong carapace from the Lingula flags, and at first referred it to *Hymenocaris*, but subsequently to a new genus, *Saccocaris*. The characters of this genus as first determined are mainly those of its first-described species, which here follows.

1. Saccocaris major, *Salter*. Plate XIV, fig. 6.

Saccocaris, *Salter*. Report Proceed. Geol. Polytech. Soc. West Riding of Yorkshire (for 1867), vol. iv, 1868, pp. 588, 589.

Hymenocaris (Saccocaris) major, *Salter*. Catal. Palæoz. Fossils Cambridge Museum, 1873, p. 7.[1]

— major, *Etheridge*. Mem. Geol. Surv., vol. iii, 2nd edit., 1881, p. 366 (in list).

— (Saccocaris) major, *T. R. Jones and H. Woodward*. Report Brit. Assoc. for 1883 (1884), pp. 219, 220.

Saccocaris major, *T. R. Jones and H. Woodward*. Ibid. for 1888 (1889), pp. 175, 176.

Saccocarix (sic), *Etheridge*. Brit. Foss., part 1, Pal., 1888, p. 55.

Saccocaris major, *Woods*. Catal. Type Foss. Camb. Mus., 1891, p. 136.

In the Woodwardian Museum at Cambridge there are three specimens labelled "*Hymenocaris ? major*," with some doubt, and possibly by Salter himself. Only one of them, however, answers to Salter's brief generic description.

This specimen (marked $\frac{A}{160}$), which most nearly corresponds with the original description, namely, "a large ovate carapace, strongly emarginate behind, and larger than *H. vermicauda*," is a relatively large, thin, filmy compressed valve, $4\frac{2}{10}$ inches long and 2 inches high (120 by 51 mm.), suboblong, with nearly parallel dorsal and ventral borders, the former straighter than the latter, which has a slight outward (downward) curve. Obliquely elliptical in front, the acme

[1] Here entered as "*Hymenocaris* (*Saccocaris*, 'Halifax Trans.,' 1867) *major*, Salter, n. s." The reference is a mistake for 'Report Proceed. Geolog. Polytech. Soc. West Riding, Yorkshire, for 1867' (Leeds, 1868). The reference is to vol. iv, p. 588, 'On *Sacocaris*, a new genus of Phyllopoda from the Lingula-flags,' by J. W. Salter, A.L.S., F.G.S.

of the curvature being above the mesial line, thus making the antero-dorsal much shorter than the antero-ventral curve.

Apparently blunt or truncate behind, with a gentle outward curve rather above the middle. The exact line of this posterior margin is not clearly seen, owing to its passing into the substance of the black schistose mudstone, the valve having been delicately plaited (with the stone), and gently undulate throughout, in lines parallel to the long axis of the valve; and pressure having acted at right angles to its length, this longitudinal plaiting (pleating) is transverse to the hind border, and the whole surface is compressed and corrugated from edge to edge. The hinder margin of the valve, indeed, is barely perceptible, having been shredded or frayed off by its extremely plaited state, or, in other words, frittered away in longitudinal shreds parallel with the plaiting of the rock, showing probably that this end was of thinner consistence than the rounded front edge, which has not been affected nearly so much, having probably been thicker, or even slightly rimmed.

This frayed condition often occurs with the ends of phyllopodous specimens in the Lingula-flags. There are also some irregular concentric lines in the antero-ventral area of the specimen, caused by depression in the convexity of the valve. By the cross-pressure the specimen must have lost something in height, and has had its length exaggerated.

The valve, slightly hollow, is probably the right-hand valve, showing its inside. Several concentric, irregular, narrow foldings, following the contour of the anterior and antero-ventral border, are apparently due to the compression of the convexity of the valve.

This specimen, No. 1 at p. 220 of the First Report, and fig. 1, p. 178, Report for 1888, is marked $\frac{A}{160}$, $\frac{b}{207}$, in the Woodwardian Museum of the Cambridge University, and was collected by Mr. D. Homfray from the upper part of the Lower Lingula-flags at Cae'n-y-coed, near Maentwrog.

This was at first (in 1867) regarded by Mr. Salter as a flat carapace, "after the manner of *Apus*;" but afterwards (in 1873) he referred it to the bivalved, folded, or Nebalioid forms of carapace, and placed it as an ally of *Hymenocaris*, with the name *Saccocaris*. In shape it differs much from the valves of that genus, as it wants their triangular form, due to the dorsal line forming an angle with the front edge, which slopes rapidly downwards and backwards all along the ventral, to join the posterior margin, with a bold, oblique postero-ventral curve. Differing also remarkably in size, it must be assigned to a different generic group, and we thought it best to recall the name which Salter was at first inclined to give it, namely *Saccocaris*.

We have met with no evidence of the body-segments alluded to by Mr. Salter, nor are the "three distinct ridges on the hinder border" recognisable. On the

upper part of the posterior region there are some small suboblong pits, which may possibly indicate the bases of former prickles or tubercles.

2. Saccocaris minor, *T. R. J. and H. W.*, 1891. Plate XIV, figs. 7—9, and fig. 10 (?).

Saccocaris minor, *T. R. Jones and H. Woodward.* Report Brit. Assoc. for 1890 (1891), p. 424, figs. 1—17.

— — *Woods.* Catal. Type Foss. Cambridge, 1891, p. 137.

On a large piece of the "Upper Shale (= Daear-fawr Shale) west of the Craig known as Craig-yr-hyrddod, Arenig," North Wales, kindly submitted by Professor T. McKenny Hughes, F.R.S., for examination, are numerous, and at first sight somewhat obscure impressions of a bivalved Phyllocarid, together with some body-segments of the same. The rock is "the top bed of shale tangled among the porphyries of the Mountain Arenig. It is, therefore, the highest fossiliferous zone of the *Arenig* of Arenig." The slab, measuring 18 by 10 inches, and half an inch thick, consists of a hard, dark-coloured, fine-grained flagstone (dark-blue within and weathering dull rusty grey), not argillaceous nor calcareous, made up of minute, fragmentary, crystalline particles. One edge is straight and ragged, and the opposite edge is rounded, as if it had been a part of a large fissile concretion. The slab separates horizontally into two parts, and the counterpart surfaces are covered with the fossil impressions, which are mainly convex on one of the faces, and concave on the other. One larger convex cast (Pl. XIV, fig. 7) lies almost alone on the rusty weathered back of the piece that bears the concave impressions. These carapaces and abdominal segments are merely dark films, more or less flattened, and squeezed across their length. Some, however, among the numerous individuals are less distorted by pressure, especially the one (fig. 7), which is isolated on a different (outer and broadly rippled) surface of the stone.

The crowded fossils lie mostly oblique to the long axis of the stone, near to each other, often close together, more or less parallel, and generally with the same end in one direction. On the plate at page 425 of the Report for 1890 some of the best preserved specimens were selected and outlined just as the individuals lie on the stone; sometimes, as figs. 1 and 2, 9, 10, and 11, 7, 15, 16, and 17, in groups. See also Pl. XIV, fig. 9.

These carapace-valves are more or less oval-oblong in outline, but often imperfect, and in nearly all cases modified in shape by pressure.

The largest individual (Pl. XIV, fig. 8), 37 mm. long and 22 mm. high (broad), having nearly its original shape, has its upper and lower edges slightly convex and nearly parallel; the upper (dorsal) edge is somewhat more fully

curved than the other, especially in the antero-dorsal region. The front end (to the left hand in the figure) was probably rounded, but is broken; the hinder extremity is obliquely truncate, but bears some indication of an ogee curvature, such as is seen in many *Ceratiocaridæ* and other Phyllocarids. Three abdominal segments (one imperfect) are still attached to this end of the carapace; the first two are about 5 mm. long, and the third about 7 mm. They appear to have been originally as deep as the carapace,[1] and each segment at its hollow curve below its convexity and lateral articulation was marked with vertical striæ.

The surface of fig. 8 bears five delicate, longitudinal, gently curved subparallel lines. These lines are partly raised and partly hollow, as if, having a consistency different from that of the rest of the valve, they have been differently affected by the pressure to which the matrix had been subjected.

Fragments of probably a specimen similar to the foregoing lay close to it, as shown by fig. 2, p. 425 of the Report for 1890 (Eighth Report).

There is a remarkable similarity in outline between Pl. XIV, fig. 8, here described, and fig. 6, namely, *Saccocaris major*, Salter. Although the relative size differs very much (110×50 mm. and 37×22 mm.), and the proportions are also somewhat different (110×50 : 101×66), we are inclined to refer the two specimens (both of which are from the Cambrian rocks) to the same genus. Probably, if it were not for the broken anterior border in fig. 8, and the broken posterior margin of *Saccocaris major*, they might have presented a still stronger likeness.

We have regarded this form as a new species, and named it *Saccocaris minor*, defined as follows:

Carapace valve suboblong, arched above, nearly straight below, elliptically rounded in front, with the acme of curvature probably coincident with the mesial line of the valve; truncate behind, with a slightly projecting and blunt angle at its upper fourth. Surface marked with five longitudinal, slightly curved, subparallel lines, somewhat like the nervures in an insect's wing; one or more of the lines seem to branch backwards. Abdominal segments present (see Pl. XIV, figs. 8 and 9, and other figs. in Report for 1890), and are of considerable interest as connecting this old form with *Hymenocaris*, *Ceratiocaris*, and other allies. Some of the caudal spines are obscurely preserved on the slab.

Owing to the pressure that has so greatly affected the specimens on the two counterpart faces of the split slab, there is considerable variation in the outlines of the individuals, nor do they quite match fig. 8, Pl. XIV. Fig. 3 (Report of 1890) measures 27×15 mm.; fig. 4 (1890), 27×10 mm.; fig. 7 (1890), 28×11 mm.; fig. 9 (1890), 23×7 mm.; fig. 11 (1890), 25×8 mm. Nevertheless some features of fig. 8, Pl. XIV, are traceable in the majority. Looking at the

[1] This would agree with Mr. Salter's suggestion that the body-rings in *S. major* were probably as high (wide) as the valve itself.

selected outlines drawn from the slab in 1890, we see the rounded front in figs. 3, 4, 5, 9, 11, 15, 17 of the Report, and partially in figs. 7, 10, and 14 of that Report. Figs. 3 and 15 (1890) retain some of the proportionate height of Pl. XIV, fig. 8; but others seem to have become narrower by cross-pressure, but this may have been an original specific feature (although very doubtful). Some trace of the hinder ogee outline is visible in figs. 3, 5, 7, 9, 11, and 15 of the Report (sometimes neater than in Pl. XIV, fig. 8); also in figs. 14 and 17, which are apparently *reversed* valves, with the dorsal edge downwards. The superficial longitudinal lines are evident in all the valves; and 4, 5, 7, and 15 (1890) show the backward branching, but in fig. 17 the branching veins seem to have a forward direction. Unequal pressure may have modified these appearances. We regard these smaller valves as being most probably immature forms, rather than showing either sexual or specific differences. Abdominal segments are attached to the valves in figs. 3, 4, 7, and 14 of the Report; and are separate in figs. 6, 8, 12, 13, and 16 of that series. In shape, size, and ornament these differ too much for us to pretend to decide whether they are really all of one kind or not, the modes and degrees of preservation probably making more distinctions than originally existed. Pl. XIV, fig. 8, represents fig. 1 of the Report, and fig. 9 comprises figs. 9, 10, 11 of the Report.

Bearing in mind the gregarious habits of modern Entomostraca, it seems most probable that we have here another illustration of the crowding together of numbers of individuals of *one species* which lived in the same shallow lagoon, a portion of which may have been dried up (as in a modern shore pool), leaving its inhabitants to perish in the sun and to be covered up with a fresh layer of mud by the next tide. Such a local accumulation of animal matter may have caused a segregation of special mineral matter in the matrix, and have given rise to the local concretion.

The slab and its counterpart from the Arenig slates, as mentioned above (p. 86), collected by Professor T. M'Kenny Hughes, are preserved in the Woodwardian Museum at Cambridge.

A small specimen of an imperfect valve in the Woodwardian Museum (marked $\frac{A}{170}$) from Wern, near Portmadoc, in a bluish schistose mudstone, weathering greenish-grey, shows a definitely sinuous (ogee) posterior margin, thus presenting a feature seen in some specimens of *Saccocaris minor* (as also in *Ceratiocaris*). This posterior moiety of a valve is 23 mm. long by 15 mm. high. We figure it here (Pl. XIV, fig. 10) as being probably of the same genus, if not of the same species as *S. minor*.

This specimen was described at p. 220 of the First Report (1883), and figured in outline at p. 179 of the Sixth (1888) Report, fig. 10, as being doubtfully a part of the valve of a *Ceratiocaris*.

VIII. *Genus*—Caryocaris, *Salter*, 1863.

Salter, 'Quart. Journ. Geol. Soc.,' vol. xix, 1863, pp. 135, 139.
Bigsby, 'Thesaur. Silur.,' 1868, p. 73.
T. R. Jones, 'Geol. Mag.,' 1883, p. 463.
T. R. Jones and H. Woodward, 'Report Brit. Assoc. for 1883' (1884), pp. 217 and 221.
— — 'Monogr. Brit. Pal. Phyllop.,' pt. 1, 1888, p. 3.
Etheridge, 'Foss. Brit.,' vol. i, Palæoz., 1888, p. 46.

Mr. J. W. Salter determined *Caryocaris* ('Quart. Journ. Geol. Soc.,' vol. xix, p. 139) as having a "bivalved carapace (with distinct hinge-pits), rounded anteriorly, subtruncate behind, and with the back and front subparallel. The surface is smooth, or with only oblique wrinkles near the margins, but with no parallel lines of sculpture." The body and abdominal appendages were unknown to Mr. Salter; but he suggested, in a restoration ('Quart. Journ. Geol. Soc.,' vol. xix, p. 137, fig. 15), a strong, tapering telson (or last body-segment), carrying a sharply lanceolate style and stylet, much like fig. 16 *a*, Pl. XI of this Monograph (Part I, 1888). Mr. Marr has found in association with *Caryocaris*, at the tramway bridge crossing the Seiont in Caernarvonshire, some small slender spines or pointed styles, from about $\frac{8}{10}$ to $\frac{12}{10}$ inch in length, which are longer than Salter's ideal figure; but Prof. Malaise, of Gemboux, Belgium, has favoured us with the loan of a specimen showing three definite sharp dagger-like stylets as the cercopods of this genus (see the figure at p. 91).

1. Caryocaris Wrightii, *Salter*, 1863. Plate XIV, figs. 11—15; and Figures 5 and 6 (woodcuts).

Caryocaris Wrightii, *Salter*. Quart. Journ. Geol. Soc., vol. xix, 1863, pp. 137, 135, fig. 15, and p. 139.
— — — Catal. Cambr. Silur. Foss. Cambridge, 1873, p. 21, woodcut.
— — *H. Woodward*. Catal. Brit. Foss. Crustac., 1877, p. 70.
— — *H. N. and E.* Catal. Camb. Silur. Foss. Mus. Pract. Geol., 1878, p. 19.
— — *T. R. J. and H. W.* Report Brit. Assoc. for 1883 (1884), p. 222.
— — *Etheridge*. Foss. Brit., vol. i, Palæoz., 1888, p. 46.

The test is smooth, thick, and somewhat horny in appearance, often with light purplish tints, sometimes black and filmy, rarely white and thick (fig. 12). The ventral margin is thickened with a raised rim; and sometimes the appearance of

two such rims arises from the impression of one valve marking the ventral region of the other. The extremities rarely exhibit any raised margin; and we have not recognised the dorsal rim nor the hinge-marks alluded to by Salter.

Owing to the relative solidity of the valves this fossil is not unfrequently preserved in shape, even when the "plaiting" or imperfect cleavage of the compressed flagstone crosses them at various angles. Hence these valves are not so much altered in form in the Skiddaw Slates as the *Hymenocarides* are in the Lingula-flags: yet occasionally, when they lie parallel with the superinduced grain of the schist, their ends are frayed out or "plaited" into a mere fringe. A very much *crumpled* specimen from near Keswick was figured by Mr. Salter in the 'Geologist,' vol. iv, 1861, p. 74, before he described the genus and species in detail.

Of the great number of individuals present in the Skiddaw Slates, the shape of most has been more or less modified by pressure. Though Mr. Salter adopted the narrow end as the anterior in his figures, we prefer to regard the broader and prow-shaped end as the front.

Taking fig. 13 (B. M. 47935) as presenting a well-preserved outline, we regard the narrow end as the posterior, vertically truncate, and very slightly sinuous; whilst the anterior end is broader (higher), with an acute angle above the medial line, and passing gently into the slightly convex dorsal margin, and with a bold elliptical curve into the strongly convex ventral margin. Fig. 14 (B. M. 42162), though somewhat crumpled, shows these features. Fig. 11 (M. P. G. $\frac{2}{5\,5}$) has both ends modified into nearly upright curves. Fig. 12 (M. P. G. $\frac{2}{5\,4}$, D $\frac{5}{1\,3\,c}$) has the anterior almost as truncate as the posterior. Fig. 15 (C. M. $\frac{A}{5\,3\,3}$, $\frac{a}{4\,7}$), has the anterior obliquely truncate. How far some of these modifications may be due to differences of growth and habit it is difficult to say, but certainly pressure has been mainly concerned with them.

With regard to size, some measure $\frac{1\,3}{1\,0} \times \frac{5}{1\,0}$ inch, or $32 \times 12{\cdot}5$ mm.; $\frac{1\,2}{1\,0} \times \frac{4}{1\,0}$ inch, or 29×10 mm.; $1 \times \frac{3}{1\,0}$ inch, or $25 \times 12{\cdot}5$ mm.; and $\frac{7}{8} \times \frac{2}{8}$ inch, or 22×6 mm.

This small, pod-like,[1] Palæozoic Phyllopod abounds in the Skiddaw Slate (Lower Llandeilo or Arenig group) at many places near Keswick—as, for instance, at Braithwaite Brow, where specimens are numerous on many bed-planes of the hard shales or flagstones; and Mr. Salter mentions Causey Pike and Grassmoor, Cumberland ('Catal. Pal. Foss. Cambridge,' 1873, p. 21). H. Woodward mentions Barff and Longside ('Catal. Brit. Crust.,' 1877, p. 70). It has been collected by Mr. J. E. Marr at the Nantlle tramway or "Wantlle railroad," Pont Sciont, near Caernarvon (Upper-Arenig group); see 'Quart. Journ. Geol. Soc.,' xxxii, 1876, p. 134. The "phyllopod crustaceans" mentioned, ibid., p. 135, and preserved in the Woodwardian Museum, Cambridge, are several specimens of *Caryocaris*, and

[1] Somewhat like the seed of the custard-apple, but more slender in shape.

some small caudal styles which may possibly have belonged to species of the genus, though they somewhat resemble those associated with the Upper-Silurian *Peltocaris* and *Discinocaris* in the Coniston Mudstone of Skelgill, also collected by Mr. Marr.

Professor Lapworth records the occurrence of *Caryocaris Wrightii* in the shales of Arenig age at Bennane Head, in the Ballantrae area, on the Firth of Clyde (' Geol. Mag.,' 1889, p. 22).

Professor C. Malaise, of Gemboux, has obligingly lent us three specimens of *C. Wrightii*, obtained by him from the Arenig series of Huy and Nannine, Belgium. Of these specimens, one is large (Fig. 5, woodcut), one imperfect, and one small with a trifid tail partly extruded from below the narrow extremity (Fig. 6, woodcut). They are black and shiny; in hard, black, micaceous shale, jointed, with ferruginous facings.

Fig. 5. — *C. Wrightii.* Compressed carapace showing right valve. Huy, Belgium.

Fig. 6. — *C. Wrightii.* Compressed carapace showing left valve and the trifid caudal appendage; with fragments of other valves? Huy, Belgium.

The small specimen with caudal appendage is of great interest: first, because it corroborates our opinion that the smaller end is the posterior extremity of the valve; secondly, because in it we have the only certain evidence of the form of the cercopods in this animal (Fig. 6, woodcut). They are not wholly exposed, but evidently comprise three lancet-shaped, flat, thin, blade-like members, one of which, apparently larger than the others, as far as they are exposed, may be the style or chief cercopod. We do not know any set of style and stylets exactly corresponding to these. Those of *Elymocaris* (Beecher, 'Report Geol. Surv. Pennsylv.,' 1884, p. 13, pl. ii, fig. 1) have a close resemblance: so also *E. ? longicauda* (Sharpe), *supra*, Part I, Pl. XI, fig. 16 *a*; and *C. patula*, ib., fig. 11. One of the nearest in shape (but not in size) is the much larger trifid set of caudal appendages belonging to a Carboniferous species of *Dithyrocaris* (undetermined) described and figured by Mr. R. Etheridge, jun., in the 'Quart. Journ. Geol. Soc.,' vol. xxxv, 1879, p. 466, pl. xxiii, fig. 2; and those of *D. testudineus*, Scouler, 'Geol. Mag.,' 1873, pl. xvi, fig. 1.

The larger specimen (Fig. 5, woodcut), measuring 27×10 mm., has the ordinary shape, like Pl. XIV, fig. 13; Fig. 6, woodcut, is smaller (19×7·5 mm.), and more crushed.

2. Caryocaris Marrii, *Hicks*, 1876. Plate XIV, figs. 16—18.

Caryocaris Marrii, *Hicks*. Quart. Journ. Geol. Soc., vol. xxxii, p. 138.
— — *H. Woodward*. Catal. Brit. Foss. Crust., 1877, p. 70.
— — *T. R. J.* Geol. Mag., 1883, p. 464.
— — *T. R. J. and H. W.* Report Brit. Assoc. for 1883 (1884), pp. 215 and 222.
— Marri[rrii], *Woods*. Catal. Type Fossils Cambridge, 1891, p. 134.

Much like *C. Wrightii* in general appearance, but smaller, being both shorter and narrower; nearly straight on dorsal and ventral margins, but sometimes slightly curved (Pl. XIV, figs. 16 and 18), probably from the effect of pressure. One end narrower and less decidedly truncate than others (fig. 17), and sometimes rounded (figs. 16 and 18), having been modified by pressure. A good specimen (fig. 17) is black, shining, and somewhat leech-like.

In the Woodwardian Museum, Cambridge, some specimens from the Upper Arenig schists on the Nantlle tramway are labelled *C. Marrii*, Hicks. 1. One, with a black test, compressed, measures $\frac{6}{10} \times \frac{3}{10}$ inch, or 15 × 7·5 mm.; and this has been so much squeezed that possibly it is now even narrower than it originally was; but the front end is broken, and the hinder end is fringed off with the "plaiting" of the rock. This seems to be *C. Wrightii*. It is somewhat thickened at the ventral edge. 2. A similar but imperfect specimen, modified with oblique "plaiting." Ventral border thickened. 3. Two imperfect specimens on one slab ($\frac{A}{440}$), one of which, probably about $\frac{8}{10}$ inch or 19 mm. long, is only $\frac{2}{10}$ inch or 3·5 mm. across (high). The ends are modified by cleavage-pressure. This (fig. 18) approaches most nearly to Dr. Hicks's description of *C. Marrii*.

A specimen in the British Museum (42162, Pl. XIV, fig. 17) has kept the shape of its ends more perfectly, and they are more decidedly truncate than in *C. Wrightii*, one extremity being more bluntly truncate and higher than the other. Another, in the Museum Pract. Geol. ($\frac{2}{5}\frac{2}{5}$, fig. 16), is truncate at one extremity, whilst the valve, narrow throughout, tapers with a rounded end at the other; and this seems to us to be probably one of the best preserved outlines of *C. Marrii*. It corresponds with a good specimen (hollow cast with $\frac{A}{5\,3\,3}$) in the Woodwardian Museum, which is 20 mm. long × 4 mm. wide, truncate at both ends, one of which is wider (4 mm.) than the other (2·5 mm), and straight throughout, not curved like fig. 16, and having a close relationship to fig. 17; whilst, with its curved outline and rounded end, fig. 16 has fig. 18 for a poor representative.

All these individuals of *C. Marrii* occur on the same slabs as, and generally close to, *C. Wrightii*. It is possible that the two forms show sexual differences.

Note.—The specimens, figs. 13, 14 (*C. Wrightii*), and 17 (*C. Marrii*), Pl. XIV, occur in greyish-black flagstone,[1] from near Keswick, traversed by numerous, parallel, dark lines, superinduced, but not affecting the shape of the fossils.

Fig. 18 (*C. Marrii*) is in a greyish-black micaceous mudstone, squeezed and jointed, joint-faces weathered brownish.

3. Caryocaris? Salteri (*M'Coy*), 1861.

Hymenocaris Salteri, *M'Coy*. Exhib. Essay[2] (in German), 1861, p. 168; Annals and Mag. Nat. Hist., 1862, vol. ix, p. 140; ibid., 1867, vol. xx, p. 201.

? — vermicauda, *Hochstetter*. Jahrb. k.-k. geol. Reichsanst., vol. xii, 1861 (Sitzungsb. k.-k. geol. Reichs.), p. 23.

? Caryocaris Salteri, *Salter*. Quart. Journ. Geol. Soc., vol. xix, 1863, p. 139 (*note*).

Caryocaris Salteri, *Bigsby*. Thesaur. Silur., 1868, p. 73.

Hymenocaris Salteri, *Bigsby*. Ibid., p. 200.

— — *R. B. Smyth*. Report of Progress Geol. Surv. Victoria, 1874, p. 33.

— — *Etheridge, jun*. Catal. Australian Fossils, 1878, p. 17.

The references to this Australian species (from Redesdale, Victoria) are given in the 'Catalogue of Australian Fossils,' by R. Etheridge, jun., 1878, p. 17. There is some uncertainty, however, as to its generic relationship; for in a paper written by Mr. Salter in 1862, and published in the 'Quart. Journ. Geol. Soc.,' vol. xix, 1863, p. 135, &c., after noticing that the Australian Graptolites sent to the International Exhibition in London (1862) were recognisable as belonging to the Llandeilo series as determined in the north of England, he adds in a foot-note (p. 139), "There is even a crustacean [from the same Australian beds] apparently of the genus *Caryocaris*, which M'Coy has done me the favour to name *Hymenocaris Salteri*." Thus it is evident that Salter saw one example, if not more, of this Australian species in 1862, and did not regard it as a *Hymenocaris*.

[1] Some of the Skiddaw slates are minutely micaceous.

[2] One of the essays prefatory to the 'Catalogue of the Victorian Exhibition at Melbourne,' 1861, German edition, 8vo, Melbourne, 1861.

B. *Shield-like Phyllopodous Carapaces sutured along the Back.*[1]

Before we proceed with the comparative descriptions, we may remark that a few little fossils,[2] similar to those about to be described, were noticed long ago by palæontologists, before the Crustacean characters of the latter were recognised; and their general likeness to the opercula of Ammonites[3] led some observers to suggest that they may have belonged to *Goniatites*, an "Ammonitidal" Cephalopod found occasionally in strata of the same formation (Devonian) as that in which certain of these Aptychus-like fossils occur.[4] Many of the real Crustacean species, however, occur in beds in which *Goniatites* are unknown.

Of the Phyllopodous forms under consideration we have some, like *Discinocaris*, which could not, on account of their shape in general, and the presence of the frontal piece in particular, have belonged to any Cephalopod. Next we have a large series of forms which occur in beds wherein no *Goniatites* have been found; and some occur in beds containing *Goniatites*, though their outlines do not correspond exactly with the apertures of the shells of such Cephalopods.

As other Phyllopods, such as *Estheria*, are imbedded in Devonian rocks, it is not strange that these Phyllocarida should be there also.

Whilst, however, we are far from denying that some forms, now associated with undoubted shield-bearing *Phyllopoda*, may hereafter be shown to be Molluscan, we are certain that some have no relation to Mollusca.

We are the more strengthened in our opinion of the affinities of the Palæozoic Crustacean shields, because the ornamentation often agrees with that of known Phyllopod carapaces, both in the minute, ridge-like, concentric lines of growth, and, in some cases, in the delicate surface-ornament between them.

Another objection to the supposed *Aptychus*-nature of many of these circular and ovate shields arises from the fact that they were not originally flat discs or plates, as may be seen by examining a series from various localities.

Thus *Discinocaris Browniana* was in some degree convex, with a low conical apex; *Aspidocaris triasica* was evidently conical, as may be seen by the split state of the outer rim, caused by the flattening of the whole shield; others, as *Lisgocaris Lutheri*, had elevated sub-conical carapaces. *Aptychopsis* not unfrequently

[1] Some Phyllocarids (*Discinocaris* and *Aptychopsis*) placed among Entomostraca were referred to in Part I of this Monograph (1888), pp. 4 and 8.

[2] *Aptychus lævigatus*, Goldfuss, 1832; *A. vetustus*, d'Arch. and de Vern., 1842; *Aptychi* of Goniatites, von Keyserling, 1846; *Aptychus dubius*, F. A. Römer, 1850; *Aptychus* of a Goniatite, F. A. Römer, 1850 (see 'Report Brit. Assoc. for 1884' (1885), p. 77.

[3] Calcareous and bipartite, *Aptychus*; corneus and undivided, *Anaptychus*.

[4] See, for instance, Dr. Dames' remarks in the 'Neues Jahrb. für Min.,' &c., 1884, pp. 275—279.

exemplifies the same condition and similar breakage. These conditions are compatible with the nature of Phyllopods.

With reference to *Goniatites* having *Aptychi* or *Anaptychi*, and as to some of the so-called Phyllopodous shields being really such parts of *Goniatites*,[1] we have to state that, in confirmation of Herr Kayser's discovery of a "*Spathiocaris*," in the body-chamber of a Devonian Goniatite,[2] we have seen some similar examples from Bicken; and that we believe some of the so-called little shield-like fossils which come from Goniatitiferous Devonian strata will have to be referred to *Goniatites*. Thus we must look with some doubt on the following Devonian forms:

Discinocaris dubia (Roemer) .	See our Second Report, 1884 (1885), p. 79.		
„ *lata* (Woodward) .	„	„	„
„ *congener* (Clarke) .	„	„	p. 80.
Spathiocaris ungulina, Clarke .	„	„	p. 81.
Pholadocaris Leeii, Woodward „ *sp.* .	„	„	p. 82.
Ellipsocaris Dewalquei, Woodward „ *sp.*	„	„	p. 83.
Cardiocaris Roemeri, Woodward „ *bipartita*, Woodward „ *Veneris*, Woodward „ *Koeneni* (Clarke) .	„	„	p. 84.
Dipterocaris pes-cervæ, Clarke „ *vetusta* (d'Arch. and de Vern.) „ *procne*, Clarke	„	„	p. 85.

These, then, require further investigation; but as numerous specimens having undoubted structural features of Phyllopods occur in the Silurian strata that do not yield Goniatites, and as some even of the genera enumerated above are not always associated with Goniatites, there is no reason why members of the group should not occur even in Goniatitiferous strata. Thus some of the foregoing species may have no relationship with the Cephalopods among which they have been buried, but were lineal descendants of Silurian forms.

In his paper in the 'Neues Jahrbuch,' &c., 1884, Band i, p. 275, &c., "On the Phyllopod-nature of *Spathiocaris*, *Aptychopsis*, and similar bodies," met with in strata of Silurian, Devonian, and Carboniferous ages in Europe and North

[1] See our Second Report, 1884, p. 76.

[2] See Kayser, 'Zeitsch. d. deutsch. geol. Ges.,' vol. xxxiv, 1882, pp. 818, 819; and von Koenen, 'Neues Jahrb. f. Min.,' &c., 1884, pp. 45, 46.

America, and described by M'Coy, Salter, Barrande, Meek, Hall, Clarke, ourselves, and others, after an elaborate criticism of the subject, Dr. W. Dames concludes:

1. That some of the bodies in question are the *Aptychi* of *Goniatites*.

2. That for others this explanation is, according to our present knowledge, inadmissible.

3. That the last are, however, in no case Phyllopods.

1. As intimated above, we accept the first conclusion. The British Museum has obtained several specimens of these Aptychus-like bodies[1] from the black limestone of Bicken; and Mr. Robert Etheridge, jun., discovered among them a specimen of a small *Goniatites intumescens* with an imperfect *Aptychus in situ* in its mouth-aperture. This *Aptychus* seems to agree most nearly in form with the so-called *Cardiocaris lata* from Budesheim in the Eifel,[2] also observed by Mr. J. M. Clarke at Bicken.[3] The other specimens of *Aptychus*-like bodies, not *in situ*, but from the same black Devonian limestone, agree very closely with Mr. Clarke's *Spathiocaris Koeneni*,[4] also from Bicken.

2. Even after all those forms of supposed Phyllopod shields which occur in beds in which Goniatites have been found shall have been re-examined, we feel convinced, with Dr. Dames, "that for others this explanation is, according to our present knowledge, inadmissable."

The first and second reports drawn up by ourselves[5] on the Phyllopoda (Brit. Assoc.) fully confirm Dr. Dames' own conclusion that *all* the simple disc-like or bivalved shells met with in the older rocks cannot be regarded as the opercula of Cephalopods. There are, indeed, many special characters about these Palæozoic Phyllopod shields that will require to be carefully examined before they can all be referred to *Goniatites*. We would draw attention to the varied form of the notch, the absence in some and the presence in others of the dorsal suture; the presence in different genera of the rostral portion of the shield in the circular and oval forms, and the possible existence in some of a hinder trigonal shield-piece (*Pholadocaris*, *Dipterocaris*); the shape of the shield itself; the ornamentation; and, lastly, the substance composing it. Usually it is possible to discern the

[1] We have also seen a specimen of *Aptychus* sent to Mr. John Edward Lee, of Torquay, by Prof. Ferd. Römer, of Breslau, and labelled "*Aptychopsis*, sp. = operculum of *Goniatites intumescens*, Upper Devonian, Bicken, near Herborn, Nassau," in Dr. Römer's own handwriting. Some of these specimens have been figured in the 'Geol. Mag.,' dec. 3, vol. ii, pl. ix, figs. 1—6, in illustration of a paper (pp. 345—352) treating of this subject in full, and of the relationship of the fossil Phyllopods under notice to Nebalia.

[2] See 'Geol. Mag.,' 1882, dec. 2, vol. ix, p. 388, pl. ix, fig. 13.

[3] 'Neues Jahrb.,' &c., 1884, vol. i, p. 181, pl. iv, fig. 2.

[4] Ibid., fig. 1.

[5] Also 'Geol. Mag.,' 1883, dec. 2, vol. x, pp. 461—464; and 1884, dec. 3, vol. i, pp. 348—356.

difference in character between crustacean and molluscan structures, as also between these and obscure ichthyic fragments.

We note the following assertion in reference to the body-rings of *Discinocaris*: "Even if the structures observed are really body-rings, no stronger proof against their phyllopod nature could be brought forward, for the body-rings, as well as all the other parts of the Phyllopod (except the shell), are *too tender and fragile* to remain recognisable in beds of such great age."[1] (Dames, *op. cit.*)

In the presence of the long array of Insect-remains, of the most delicate and fragile characters, discovered in the Devonian and Carboniferous formations of North America, France, England, and elsewhere, this argument against the possibility of delicate organisms being preserved falls to the ground, whilst the relative thickness and durability of the calcareous or chitinous covering of the body-segments in these ancient Crustacea afford no proof for or against their Phyllopod nature, any more than does their relatively greater size when contrasted with existing Entomostraca. Moreover body-rings of *Ceratiocaris* are by no means rare in some Silurian strata.

3. In the third conclusion, "that even those forms which cannot be referred to *Aptychi* of Cephalopods are in no case the shields of Phyllopods," Dr. Dames is simply stating a matter of opinion, for of their exact nature and true zoological position Claus himself (to whom he seems to refer) is not at all positive, whilst Dames admits that he has not examined the original specimens.[2]

IX. *Genus*—Aptychopsis, *Barrande*, 1872.

Barrande, 'Syst. Sil. Bohême,' vol. i, Supplement, 1872, pp. 436 and 455.
H. Woodward, 'Geol. Mag.,' vol. ix, 1872, p. 564.
H. Woodward, 'Report Brit. Assoc.' for 1872 (1873), p. 323.
Armstrong, Young, and Robertson, 'Catal. Western-Scottish Fossils,' 1876, p. 7.
H. Woodward, 'Catal. Brit. Foss. Crustac.,' 1877, p. 69.
Nicholson and Etheridge, jun., 'Monogr. Sil. Foss. Girvan,' vol. i, 1880, p. 24.
T. R. Jones, 'Geol. Mag.,' 1883, p. 462.
T. R. J. and H. W., 'Report Brit. Assoc.' for 1883 (1884), p. 216.

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[1] Prof. A. von Koenen, replying to Herr Dames on behalf of Mr. J. M. Clarke, very justly observes, "I cannot see that this at all meets the argument, since the relative age of strata is of little influence on the preservation of fossils; on the other hand, there are plenty of examples in which fossil animals have been furnished with hard, horny, and even calcareous parts which are wanting in their nearest recent analogues. I will only recall here *Aptychus* and *Anaptychus*" ('N. Jahrbuch,' &c., 1884, Bd. ii, p. 45). The recent *Nautilus* has a fleshy hood; the fossil Ammonite had usually a hard calcareous *operculum*, but in some Liassic forms the operculum was *horny*.

[2] See our observations on this subject at pp. 4—8 of Part 1 (1888) of this Monograph.

T. R. J. and H. W., 'Geol. Mag.,' 1884, pp. 349 and 354.
T. R. J. and H. W., 'Report Brit. Assoc.' for 1884 (1885), p. 87.
T. R. J. and H. W., 'Monogr. Brit. Pal. Phyllop.,' pt. 1, 1888, p. 2.
Etheridge, 'Foss. Brit.,' vol. i, Palæoz., 1888, p. 45.

A circular or elliptical, slightly convex, tripartite shield or carapace; divided by a median "dorsal" suture extending from the posterior margin forward to within half, or a third, or a fifth, of the length of the test, according to the shape of the latter, and then meeting the apex of a symmetrical V-shaped suture, which extends to the front margin at different angles in different species. This angular ("nuchal") suture forms a line of much weaker resistance than the longitudinal suture; and the carapace has very frequently given way after the death of the animal, and allowed the triangular ("rostral," "cephalic," or "complementary") portion to be removed, together with the anterior limbs and soft parts of the animal as suggested by Dr. H. Woodward.[1] Thus an angular notch is often present in the forepart of the fossil carapace. The median suture has often been pressed inwards, but sometimes it has parted, leaving the two larger parts of the test separate. These remain as sub-triangular plates (the principal or lateral parts), straight-edged and angular on the inner margin, and either elliptically curved or almost semi-circular on the outer or free borders. They occur usually as black carbonaceous films on the bed-planes of the strata; but sometimes they have a somewhat corneous or chitinous appearance.

A concentric linear ornament covers the whole shield; numerous delicate ridges and furrows, following the curve of the outer margin, are concentric to the point where the dorsal and nuchal sutures meet in front of the centre of the test. The style of ornament is similar to that of the bivalve *Estheria*, which shows a neat arrangement of raised lines of growth, concentric with the umbones. In the case of *Ellipsocaris*, even the interlinear sculpturing is present ('Geol. Mag.,' Oct., 1882, p. 445). Delicate radiate striæ, crossing the concentric lines, are sometimes visible. If the two valves of *Estheria* be laid open, back to back, their surface would represent the shield of *Aptychopsis;* the open angle then formed by their anterior margins would be analogous to the nuchal notch; and for that of their hinder margins we may find an analogue in the split posterior border of *Dipterocaris* and other forms allied to *Aptychopsis*.

M. Barrande indicated the existence of this genus in his 'Parallèle entre la Bohême et la Scandinavie,' 1856, p. 62; here he also stated that Prof. Angelin had found the same kind of fossil in Dalecarlia and Gothland in Upper Silurian strata, at about the same horizon (Angelin's Regiones D et E in the former and Regio E in the latter country) as that in which they occur in Bohemia (étage calcaire inférieur E). See also 'Sil. Syst. Bohême,' vol. i; Suppl., p. 455.

[1] 'Quart. Journ. Geol. Soc.,' xxii, p. 504; and 'Geol. Mag.,' dec. 2, vol. ix, 1882, p. 387.

M. Barrande's careful and elaborate account (*op. cit.*) of what was known of *Aptychopsis* up to 1872 is almost sufficient in every respect.

In the Sixth Report on Fossil Crustacea to the British Association for the Advancement of Science, in 1872, Dr. Henry Woodward defined some Phyllopodous species and grouped them under the same name (independently arrived at) as M. Barrande proposed in the same year (see above). See also Dr. H. Woodward's note on *Peltocaris*, *Discinocaris*, and *Aptychopsis* in Nicholson and Etheridge's 'Fossils of the Girvan District,' 1880, pp. 210, 211.

M. Barrande included with doubt another form in this genus, namely, his *Aptychopsis? inflata*, 'Syst. Sil. Bohêm.' vol. i; Suppl. p. 459, pl. xxxiii, figs. 22, 23. But this seems to be a *Bolbozoe*, and may stand as *Bolbozoe? inflata* (Barrande), from the hills between Lodenitz and Bubowitz, Étage E, e 2.

There are no Goniatites in 'Étage E,' representing the lower part of the "Fauna III," which is equivalent to the Upper Silurian. There are, however, some Goniatites (five species), rather higher up, in "Étage F," which is in the middle part of "Fauna III."

We have to remark that in *Aptychopsis* the form and proportions of all three valves (lateral and rostral) and their relative position have been so much altered by pressure and other accidents of fossilisation that it is often difficult to fix upon safe data for judging of the exact relationship of the different forms. This is especially the case with the size and angle of the nuchal notch, which, as Barrande has suggested, may have differed with the age of an individual. Therefore the shape of the carapace and of its two lateral moieties or valves, and the character of their ornament, are to be chiefly considered. The following are the recognisable forms of *Aptychopsis* which we have met with:

Bohemian.	1. *A. prima*, Barrande, op. cit., pl. xxxiii, figs. 10, 12, 16, 19—21. Obovate, subcircular.	Upper Silurian.
—	— var. *longa*, nov. Loc. cit., fig. 11. Obovate, long.	Upper Silurian.
—	— var. *secunda*. Loc. cit., figs. 1—9, 13—15, 18. Circular.	Upper Silurian.
British.	2. *A. Barrandeana*, sp. nov. Pl. xv, fig. 1. Obovate, long, tapering posteriorly.	Upper? Silurian.
—	2*. — — var. *brevior*, nov. Obovate, tapering posteriorly.	Upper? Silurian.
—	3. *A. cordiformis*, sp. nov. Pl. xv, fig. 2. Obovate, acute posteriorly.	Middle? Silurian.
—	4. *A. lata*, sp. nov. Pl. xv, fig. 6. Obovate, broad, subcircular, acute posteriorly.	Middle? Silurian.
Bohemian? and British.	5. *A. glabra*, H. Woodward. Pl. xv, fig. 11. Circular, small.	Upper Silurian.
British.	6. *A. Wilsoni*, H. W. Pl. xv, figs. 12 (?), 15, 16. Circular, large.	Upper Silurian.
Bohemian? and British.	7. *A. Lapworthi*, H. W. (Barrande, op. cit., pl. xxxiii, fig. 17 ?). Pl. xv, figs. 7, 3, 10, 8, 9, 22.[1] Oval.	Middle Silurian.

[1] The *order* of similarity or relationship is thus indicated here and elsewhere.

British. 8. *A. ovata*, sp. nov. Pl. xv, figs. 4 and 5. Ovate. Middle Silurian.
— 9. *A. Salteri*, H. W. Pl. xvii, fig. 6. Suboval. Upper Silurian.
— 10. *A. subquadrata*, sp. nov. Pl. xv, fig. 20. Subquadrate. Lower Silurian.
— 11. *A. angulata* (Baily). Pl. xv, fig. 19. Oblate. Lower Silurian.
— 12. *A. oblata*, sp. nov. Pl. xv, figs. 21, 18, 23. Deeply oblate, wide. Middle Silurian.

No Goniatites have been found with any of these.

We propose in the first place to propound the characters and history of Barrande's typical species *A. prima*, no exact representative of which we have yet met with in Britain.

1. Aptychopsis prima, *Barrande*, 1872. Woodcuts: Fig. 7; and Fig. 10, p. 109.

Aptychopsis primus, *Barrande*. Silur. Syst. Centre Bohême, vol. i, Supplem., 1872, p. 457, pl. xxxiii, figs. 1—21 [*A. prima*, var. *secunda*, &c.].
— — *Römer* (after *Barrande*). Leth. Geogn., 1876, pl. xix, figs. 3 *a*, 3 *b*.
A. prima et var. secunda, *T. R. J. and H. W.* Geol. Mag., 1884, pp. 349 and 354.
— — — Report Brit. Assoc. for 1884 (1885), pp. 79 and 89.

Aptychopsis prima includes, according to M. Barrande (*op. cit.*), round, subcircular, oval, and obovate forms of the tripartite shield-like test, which both Barrande and H. Woodward termed *Aptychopsis* independently in in the same year (1872). Among the figures (when completed in outline) on pl. 33, of 'Syst. Sil. Bohême,' vol. i, Supplem., *circular* or *subcircular* forms are represented by figs. 1—9, 13—15, and 18; and more or less *obovate* tests by figs. 11 (obovate); 10, 12, 16, 19—21 (broad-obovate); and 17 (*oval*). Thus there are four somewhat different shapes among these figures.

Fig. 7.—Specimen of *Aptychopsis prima*, Barrande, from Bubowitz, Bohemia. Typical form. British Museum.

In the British Museum (Natural History) are some specimens labelled by M. Barrande many years ago, as "*Aptychus? primus* (I, 2587)" and "*Aptychus? secundus* (I, 2588)." The former, when perfect, with the two lateral moieties and the frontal (cephalic or rostral) piece in place, were broad-obovate (woodcut, Fig. 7); and the latter (when perfect) were nearly or quite round. Evidently our deceased friend had decided to group these two kinds together, by the time he published the Supplement of the first volume of his great work treating of these and other Crustaceans. The circular shields found in Bohemia are chiefly from the schistose or slaty mudstone of Borek, with some from Litohlow and Kozel,—all in Étage "E, e1"; and the

obovate forms come from the same geological origin, but in limestone at other localities, as Butowitz, Slawick, and Wohrada, and rare at Kozel.

We think that "*secunda*" will serve as a varietal name for the round or nearly-round forms, as suggested by us in the 'Geol. Mag.,' 1884, pages 349 and 354, and 'Report Brit. Assoc. for 1884' (1885), pages 76 and 89; M. Barrande's term "*Aptychopsis prima*" being kept for the obovate carapaces; and, if the oval form (fig. 17 of Barrande's plate) matches *A. Lapworthi*, H. W., it is already provided with a specific appellation.

Taking *A. prima*, or the subcircular-obovate form, as typical, on the evidence of the labelled Bohemian specimens in the British Museum (see woodcut, Fig. 7), we know them as having carapaces 25 to 32 mm. long, by 23 to 33 mm. wide, and with the nuchal suture having an angle of about 90° or 100°. See Barrande's figs. 10, 12, 16, 19—21. His fig. 11 may be regarded as *A. prima*, var. *longa* (34 by 28 mm.).

2. Aptychopsis Barrandeana, sp. nov. Plate XV, fig. 1; and var. brevior, fig. 14.

At first we regarded our specimens Pl. XV, figs. 1 and 14, as being *A. prima*, Barrande; but we now distinguish important differences between the forms.

The two specimens in the British Museum, in limestone from Bubowitz, and labelled "*Aptychus? primus*" by M. Barrande, have (if complete) the obovate shape of several of Barrande's figures, and more particularly correspond to his fig. 19. Our fig. 1 is longer and proportionally narrower at the posterior third than any of the Bohemian specimens or figures; so also our fig. 14 (variety) is much narrower posteriorly, with a straight and more sloping outer margin, compared with any of them. They both also have a shallower and wider notch than the Bohemian forms.

This large and distinct species is here named in honour of the eminent palæontologist of Bohemia, who was one of the first to give attention to these phyllopodous fossils.

Pl. XV, fig. 1, is a large left valve, imperfect from the loss of a considerable portion of its upper outer angle; part, however, of the left nuchal slope is distinct, with a very low angle. Measurements:[1] the dorsal suture is 31 mm.

[1] To save trouble the following arrangement of signs may be adopted:

For the vertical suture |
For the breadth of a single valve —
For the left side of the notch ⅄
For the right side of the notch ∠
For the width or gape of the notch ⊢
For the depth of the notch I
For the angle of the notch V

long; the breadth of the single valve, 18 ? mm.; slope of the angular suture, 16 ? mm. at 30°; breadth or gape of the nuchal notch, 29 ? mm.; depth of notch, 12 ? mm.; angle of the notch 120°. The two valves united would have a sagittate outline; and the whole carapace would be acute-obovate in shape. The proportion of width to length as 28 to 43 (?).

A. Barrandeana occurs in a black softish shale; and is flattened, cracked, and slightly pyritous. The concentric rings are rather broad; narrower at the outer margin, and close together at the inside (sub-central) angle.

From Dobbs Linn, Moffat.[1] In the Museum of the Geological Survey of Scotland, marked M 4418. (The classification of the successive formations in the Moffat district and vicinity has been worked out by Professor Dr. C. Lapworth, F.R.S., see 'Geol. Mag.,' vol. ix, 1874, pp. 533—6; 'Quart. Journ. Geol. Soc.,' vol. xxxiv., 1878, pp. 240—346; and 'Proceed. Belfast Nat. Field-Club,' ser. 2, vol. i, part 4, Appendix IV, 1878; also 'Catal. Western-Scottish Fossils,' by Armstrong, Young, and Robertson, 1876, p. 24, and 'Geol. Mag.,' 1889 (dec. 3, vol. vi), pp. 20—24, 59—64. Although numerous Phyllopod shields have been met with, no Goniatites have been recorded from these beds.)

Pl. XV, fig. 14, an elliptico-triangular left valve, rounded (probably from damage) at the angles. It is near *A. Barrandeana* in the straight slope of the posterior margin; but is shorter and proportionally broader. It may be regarded a variety (*brevior*) of that species. Measurements: |, 18 (?) mm.; —, 12 mm., ⧋, 7 (?) mm. at 40°; ⌐, 10 (?) mm.; I, 7 (?) mm.; ∨, 100°. Two valves sagittate; perfect carapace, obovate, tapering downwards, or long cordiform, with a wide shallow notch above. Proportion of width to length about 24 to 25.

In black, thin mudstone. Valve thin, black, shiny, crumpled, and cracked. Concentrics broad, and crossed by numerous delicate, raised, rugulose striæ, radiating from the inner angle; these are comparable[2] with those shown on Barrande's figs. 4, 18, and 20, pl. 33, *op. cit.*, and p. 457. This form approaches Barrande's fig. 19 in size, but the latter is broad-obovate and subcircular, whilst our fig. 14 does not affect the circular shape, being slanting and narrowed on its posterior third, like Pl. XV, fig. 1. It is referred to in the 'Report Brit. Assoc.' for 1884 (1885), p. 91.

Moffat beds ? British Museum. I, 2585.

Note.—Pl. XV, fig. 1, is comparable with fig. 3 in the plate illustrating Mr. J. M. Clarke's paper on "New Phyllopod Crustaceans from the Devonian of Western New York," in the 'American Journal of Science,' 3rd Series, vol. xxiii, 1882,

[1] This locality is described by Prof. Lapworth in the 'Quart. Journ. Geol. Soc.,' vol. xxxiv, pp. 247, 306, 310, 313.

[2] Also with the ornament in *Pterocaris Bohemica*, Barrande, op. cit., p. 464, pl. xxv, figs. 25 and 26, a unique fossil of a different alliance.

pp. 476—478. The specimen there referred to (p. 477) is regarded by the author as showing the lateral aspect of a folded carapace of *Spathiocaris Emersoni*, Clarke, figured on the same plate (figs. 1 and 2). Though there appears at first sight to be a difficulty in reconciling these figures,[1] we are assured by Mr. J. M. Clarke (in letter dated July 11th, 1892, in answer to enquiry on the subject) that the fig. 3 referred to above is not nearly so satisfactory as fig. 12 among his later illustrations, described in detail in the 'Nat. Hist. New York, Palæontology,' vol. vii, 1888, p. 199, pl. 35, figs. 12—18, where both the open and the folded carapaces are fully treated of. Here also the author has defined and illustrated the gradational forms in successional stages of growth in *Spathiocaris Emersoni*, from the most minute, only 2 mm. long, to one of 28 mm., and he has a fragment of one that was upwards of 80 mm. in length.

3. Aptychopsis cordiformis, sp. nov. Plate XV, fig. 2.

This obovate carapace (now wanting the front plate) is proportionately shorter and broader than *A. prima*, and intermediate to that species and its var. *secunda* in shape. It has a narrower notch than either. Pl. XV, fig. 2, shows a pair of valves, one of them imperfect. Measurements: |, 15 mm.; —, 9 mm.; ∧, 7 mm. at 60°; ⌐¬, 7 mm.; I, 6 mm.; ∨ 60°. Two valves, rather broadly sagittate; carapace acute-obovate. Concentrics broad. In dark-grey, solid, much crushed, finely micaceous mudstone. The proportion of width to length is as eighteen to twenty-one. This, though obovate, is more acute posteriorly and is narrower and sharper behind than any of Barrande's figured specimens.

From Lower Wenlock beds, Rebecca Hill, Ulverston. Coll. Marr. Cambridge Museum. See 'Catal. Type Fossils Woodwardian Museum,' 1891, pp. 133 and 136, and 'Report Brit. Assoc.' for 1884, p. 93. This has been labelled "*Peltocaris anatina*, Salter," and was referred to under that name in the 'Catal. Cambridge Fossils, &c.,' 1873, p. 93; but the frontal notch is *angular*. The median sutural line is raised along the depressed shield, and broad concentric striæ are present.

P. anatina is probably a different specimen in the Cambridge Museum.

[1] See our Second Report in 'Rep. Brit. Assoc.' for 1884 (1885), p. 81.

4. Aptychopsis lata, sp. nov. Plate XV, fig. 6.

One left valve belonging to a subcircular carapace, which, when perfect, was much broader across its anterior third than in its posterior region. The latter is narrowed suddenly, giving a sub-cordiform outline to the perfect shield. Measurements: |, 15 mm.; —, 11·5 mm.; Δ, 9 mm. at 60°; ⌒, 9 mm.; I, 8 (?) mm.; ∨, 60°. The frontal piece would have been more than half the length of the dorsal suture; and the whole shield probably 23 mm. long by 23 mm. where widest. The two valves would be broadly sagittate, or acute cordiform, with re-entrant angle above; the carapace, sub-cordiform, or broad and acute obovate. Proportion: anterior width equal to length.

This is like *A. Barrandeana* and *A. cordiformis* in the narrowing of the posterior region; but it is much shorter and relatively broader than fig. 1, and longer than fig. 2; it has a deeper notch than figs. 1 and 14, and a larger notch than fig. 2, indicating a relatively larger rostral piece. It is not sufficiently circular to match either *glabra* or *Wilsoni*.

In buffish, hard, micaceous shale; the valve has left a rusty impression, with a strong outer rim partially preserved. From a stream east of Nether Stennies Water, six and a half miles north-north-west of Langholm, Dumfriesshire. Mus. Geol. Survey Scotland. M 457 c.

5. Aptychopsis glabra, *H. Woodward*, 1872. Plate XV, fig. 11.

Aptychopsis glabra,		*H. Woodward.*	Geol. Mag., 1872, p. 565.
—	—	—	Report Brit. Assoc. for 1872 (1873), p. 323.
—	—	—	Catal. Brit. Foss. Crust., 1877, p. 69.
—	—	*T. R. J. and H. W.*	Geol. Mag., 1884, p. 354.
—	—	—	Report Brit. Assoc. for 1884 (1885), p. 91.
—	—	*Etheridge.*	Brit. Foss., vol. i, Palæoz., 1888, p. 41.

This unique test, originally circular, has been obliquely flattened, but still retains the appearance of having been "finely striated concentrically."

There are two Bohemian specimens in the British Museum (I, 2588) labelled "*Aptychus ? secundus*," by M. Barrande, which are near allies to this form; as also are figs. 1—9, 13—15, 18, in pl. xxxiii of the 'Sil. Syst. Bohême,' vol. i, Suppl. The two small and round individuals thus labelled (15 mm. in each diameter, nuchal suture with slope of 40°), in shaley mudstone from Borek, may be regarded, as stated above (p. 101), as *Aptychopsis prima*, var. *secunda* (Barrande).

The specimen shown by Pl. XV, fig. 11, is that described in 1872. It has been

modified by pressure, but, if restored, would be circular. The notch is wide and deep, rather more than half the length of the dorsal suture. The concentrics numerous and narrow. In these two valves (somewhat obliquely squeezed) the measurements are |, 11 mm.; —, 8 mm.; △, 6 mm. at 60°; ⌒, 6 mm.; I, 6 (?) mm.; ∨, 60. Two valves, round-ended sagittate; carapace circular; width and length about equal.

This specimen, named *A. glabra* in 1872, has nearly the same proportions as *A. prima*, var. *secunda*; and is like *A. Wilsoni*, but is smaller, and has a relatively smaller notch and no marginal rim. Although apparently smooth, it retains indications of numerous fine concentric lines, as usual in *Aptychopsis*, and, in so far, not quite in accordance with the smoothness intimated by "*glabra*."

In buff-coloured, very finely micaceous shale. Valves brown, with a trace of a black film, and with minute vermicular hematitic concretions. From the Buckholm beds, Gala series; Meigle, Galashiels, Selkirkshire. Coll. Lapworth. Brit. Mus. No. 59620.

6. Aptychopsis Wilsoni, *H. Woodward*, 1872. Plate XV, figs. 12 (?), 15, 16.

Aptychopsis Wilsoni, *H. Woodward.*			Geol. Mag., 1872, p. 565.
—	—	—	Report Brit. Assoc. for 1872 (1873), p. 323.
—	—	—	Catal. Brit. Foss. Crust., 1877, p. 70.
—	—	*T. R. J. and H. W.*	Geol. Mag., 1884, p. 354.
—	—	—	Report Brit. Assoc. for 1884 (1885), p. 89.
—	—	*Etheridge.*	Foss. Brit., vol. i, Palæoz., 1888, p. 41.

This species has a discoidal shield, and was briefly described in 1872 as having an angular nuchal suture (making a triangular cephalic plate), and a well-marked median or dorsal suture, and as measuring $1\frac{1}{2}$ inches in length by $1\frac{3}{8}$ inches across. There are three specimens of *Aptychopsis Wilsoni* in the British Museum, and they would probably be almost round in outline if quite perfect. They are from the Riccarton beds (Wenlock beds, Upper Silurian), at Shankend, Slitrig Water, near Hawick; Yad's Linn, near Hawick; and Elliottsfield, near Hawick, Dumfriesshire.

We may add that the cephalic notch is not so deep as in some allied forms; its apex was about one third of the length of the median suture from the front edge of the shield. Concentric lines are apparent on some specimens.

One large specimen would measure 40 mm. in each diameter if complete; its nuchal suture slopes 40°. Another specimen (imperfect) measures 30 mm. across,

and has a nuchal slope of 60°; difference of pressure has probably caused this discrepancy.

Pl. XV, fig. 15, two valves, almost perfect; measurements, |, 19 mm., —, 13 mm.; △, 10 mm. at 40°; ⌒, 15 mm.; I, 8 (?) mm.; ∨, 100°. The two valves very broadly and bluntly sagittate; carapace circular.

In dark-grey shale, weathering brownish. Valves rusty impressions. Concentrics nearly obliterated, but apparently were numerous and irregular in width. Mus. Geol. Surv. Scotland. Marked 1/13/4/92.

Pl. XV, fig. 16, two valves, similar to but larger than fig. 15, and more distorted by pressure. |, 26 mm.; —, 17 mm.; △, 12 mm at 30°; ⌒, 17 (?) mm.; I, 8 (?) mm.; ∨, 120°. Valves and carapace as in fig. 15 (allowing for distortion). In thin, grey, mottled ashbed (?), finely micaceous, weathering reddish. Valves rusty impressions; concentrics numerous and irregular; outer rim present in places.

From the Riccarton beds, Yad's Linn, near Hawick. Coll. Lapworth. British Museum. No. 59621.

Pl. XV, fig. 12, may possibly be a fragment of a small *A. Wilsoni*. It consists of the imperfect anterior portions of two valves, with concentric lines, distinct, numerous, and irregular. Measurements: |, 10 (?) mm.; —, 8 mm.; △, 7 mm. at 40°; ⌒, 11 mm.; I, 5 (?) mm.; ∨, 100°.

In a hard, grey, micaceous shale. Longside Burn, Shankend, Roxburghshire. Mus. Geol. Surv. Scotland. M 902 c.

7. Aptychopsis Lapworthi, *H. Woodward*, 1872. Plate XV, figs. 3, 7—10, 22.

Aptychopsis prima, *Barrande* (part).			Syst. Sil. Bohème, vol. i, Suppl., 1872, p. 457, pl. xxxiii, fig. 17 only.
—	Lapworthi, *H. W.*		Geol. Mag., 1872, p. 354.
—	—	—	Report Brit. Assoc. for 1872 (1873), p. 323.
—	—	—	Catal. Brit. Foss. Crust., 1877, p. 70.
—	—	*Lapworth.*	Quart. Journ. Geol. Soc., vol. xxxiv, 1878, p. 331 (in list).
—	—	*T. R. J. and H. W.*	Geol. Mag., 1884, p. 354.
—	—	—	Report Brit. Assoc. for 1884 (1885), p. 90.
—	—	*Etheridge.*	Brit. Foss., vol. i, Palæoz., p. 41.
—	—	*Woods.*	Catal. Type Foss. Cambridge, 1891, p. 133.

This Phyllopod shield was briefly described by Dr. H. Woodward in his Report on Fossil Crustacea, Brit. Assoc., for 1872. It is oval in shape, longer in the fore and aft direction than in the transverse diameter. Concentric striæ are

preserved in most of the examples, and in two cases the cephalic plate is retained. The best specimen (fig. 9) has this plate in place, but the edges of the notch have been slightly damaged and disturbed by pressure, so that its angularity is somewhat modified. The angle of the nuchal suture is about 60°. In outline the valves are shorter and fuller (more convex) on the posterior outer margin than in *A. prima*, and therefore correspond to fig. 17 in Barrande's plate, and which we separate from *prima* and its var. *secunda*.

Pl. XV, fig. 7, a left valve, with trace of a right. | , 12 mm.; —, 9 mm.; ⧹, 6 mm. at 45°; ⌒, 9 mm.; I, 6 (?) mm.; ∨, 90°. The two valves broadly sagittate. Carapace oval. In dark-grey thin mudstone, very finely micaceous. Valve structureless, black film; no concentric lines, but roughly impressed by the minutely concretionary surface of the stone. From the Grieston Shales of the Gala group at Inverleithen, above the Moffat group, and equivalent to the upper part of the Middle Silurian. Coll. Lapworth. No. 59620, British Museum.

Pl. XV, fig. 3, two valves, narrowed by crush. | , 10 mm.; —, 3 mm.; ⧹, 4 mm. at 60° (?); ⌒, 4 mm.; I, 4 (?) mm.; ∨, 60° (?). The two valves subsagittate. Carapace in present condition narrow; oval or elliptical.

This specimen has been narrowed by lateral pressure acting obliquely across the long axis of the shield, as is indicated by imperfect cleavage-planes crossing the modified test at an angle of about 60°. The frontal notch has been narrowed and its sides made unequal.

In hard black mudstone, much like that of Rebecca Hill (Pl. XV, fig. 2). Valves somewhat pyritous, modified by cleavage-pressure almost at right angles to the long axis of the valves. Graptolitic mudstone, No. 9, Skelgill beds; Skelgill Beck. Coll. Marr. Woodwardian Museum, Cambridge. See Catal. Type Fossils Woodw. Mus., 1891, p. 133.

What seems to be a similar example of a modified *Aptychopsis*, squeezed into an even narrower and more lanceolate shape, has been figured by Mr. James Dairon in the 'Transactions of the Geological Society of Glasgow,' vol. vii, part i, 1883, pl. vii, fig. 35, and referred to in the explanation of the plate as "*Discinocaris Browniana*, var. *ovalis*," Dairon.[1]

Pl. XV, fig. 10. Two valves flattened and imperfect. | , 10 mm.; —, 4 mm.; ⧹, 4 mm. at 60°; ⌒, 3 mm.; I, 4 (?) mm.; ∨, 60° (?). The two valves subsagittate; carapace elliptical. In black, finely micaceous shale. Valves thin, flattened, and

[1] All the little Phyllopod tests figured in this pl. vii are from Moffat (p. 177), and, excepting fig. 29, are termed "*Discinocaris Browniana*" by Mr. Dairon; but most of them appear to belong to other genera. Fig. 29 is *Peltocaris Carruthersii*. Figs. 31 and 34 are round shields of probably *Aptychopsis glabra*, H. W. Fig. 35 seems to be a specimen of *A. Lapworthi* much narrowed by pressure. Fig. 32 is probably a broad *Aptychopsis*, like *A. oblata*; if it be really a *Discinocaris* (*D. undulata?*) it should not have the dorsal suture.

cracked by pressure; concentric lines rather broad, but smaller than in fig. 1. Moffat Shales; Dobbs Linn. Mus. Geol. Survey Scotland. M. 4321c.

Pl. XV, fig. 8. Two valves flattened and separated; grey films of decomposed pyrites; concentrics rather broad. | , 8 mm.; —, 6 mm.; △, 4 mm. at 60°; ⌐, 4 mm.; I, 4 (?) mm., ∨, 60°. Two valves round-ended sagittate; carapace oval. In dark-grey mudstone, very finely micaceous; joint weathering reddish. Birkhill Shales, Sundhope Burn. Coll. Lapworth. Brit. Mus. I, 2593.

Pl. XV, fig. 9. Perfect carapace; the specimen described in 1872. Measurements: | , 11 mm.; —, 8 mm.; △, 5 mm. at 60°, ⌐, 5 mm.; I, 5 mm.; ∨, 60°. The two valves represent a broad-ended sagittate form; the carapace is oval. Proportion: width 14 to length 16. In a thin dark mudstone, finely micaceous. The valves are black films on a rusty ground; the concentrics are rather broad; the rostral piece is present, but has been slightly shifted.

This is from the Birkhill Shales (upper part of the Moffat Shales, and equivalent to the Llandovery Series) at Eldinhope[1] in the Eldinburn, on the Yarrow, Selkirkshire.[2] Coll. Lapworth. No. 59620, Brit. Museum.

Pl. XV, fig. 22, a small perfect carapace; the parts very slightly disturbed. Whole length 5 mm. (dorsal suture 4 mm., notch 1 mm. deep); breadth of one lateral moiety or valve 1·5 mm., side of the notch 1·5 mm. long at 60°, width of notch 2 mm., angle of notch 60°. Proportion, width 3 to length 5. In a dark-red micaceous shale. Moffat, Dumfriesshire. British Museum. No. 58868.

8. Aptychopsis ovata, sp. nov. Plate XV, figs. 4 and 5; and Woodcut, Fig. 9, p. 109.

This is apparently a distinct species, being ovate (rather broader behind than in front), smooth, and having a strong marginal rim.

Pl. XV, figs. 4 and 5. These are two ovate or suboval shields, larger than the somewhat similar figs. 9 and 22, and destitute of concentric lines (possibly from the effect of fossilisation).

Fig. 4 retains the rostral piece, but each valve has been modified by oblique pressure, and shows no remnant of the test. It measures, | , 15 mm.; —, 10 mm.; ⌐/ , 8 mm. at (?); ⌐, 8 (?) mm.; I, 7 (?) mm.; ∨, ?. Proportion, width to length as 20 to 22. The two valves broad and roundly sagittate; carapace ovate. Shorter than *A. Salteri*, and with a fuller curve on the posterior third.

In brownish-grey, hard, micaceous shale; valves rusty, slightly oblique and imperfect, as is also the triangular piece at the top edge. The outer margin

[1] See 'Quart. Journ. Geol. Soc.,' vol. xxxiv, p. 280, &c.

[2] Op. cit., p. 282.

has had a strong rim, which is partly preserved. From Stennies Water, six and a half miles north-west of Langholm, Dumfriesshire. Mus. Geol. Survey, Scotland. M, 462 c.

Pl. XV, fig. 5, retains one perfect and one imperfect valve; the notch is empty. It measures: |, 17 mm.; —, 10 mm.; _/, 7 mm. at 45°; ,_, 9 mm.; I, 6 (?) mm.; ∨, 90°. Proportion, width to length as 20 to 23. In buffish-coloured, hard, micaceous shale (like that of fig. 4); valves, rusty impressions; the outer rim is partly preserved. Stennies Water, Dumfriesshire. Mus. Geol. Survey, Scotland. M, 466 c.

9. Aptychopsis Salteri, *H. Woodward*, 1882. Plate XVII, fig. 6; and Woodcut, Fig. 8.

Aptychopsis Salteri, *H. Woodward*. Geol. Mag., 1882, p. 389, pl. ix, fig. 17.
— — *T. R. J. and H. W.* Geol. Mag., 1884, p. 355.
— — — Report Brit. Assoc. for 1884 (1885), p. 91.

This distinctly marked species had a suboval outline when perfect. The surface is finely striate and rather undulate concentrically, and the outer border seems to have had the edge bent downwards.

This carapace differs from *A. glabra* (Pl. XV, fig. 11) and *A. Wilsoni* (figs. 15

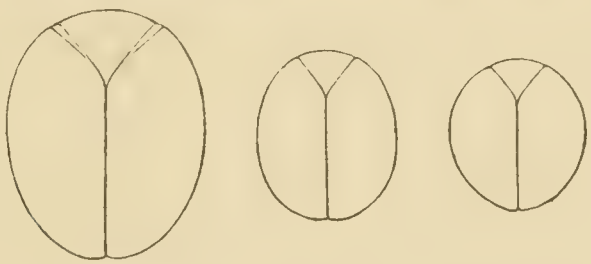

Fig. 8.—*Aptychopsis Salteri.* Fig. 9.—*A. ovata.* Fig. 10.—*A. prima.*

All three of natural size and restored as to outline.

In *A. Salteri* the width is to length as 26 to 33 mm.; *A. ovata*, 18 to 33 mm.; *A. prima*, 18 to 21 mm.; var. *secunda*, 19 to 19 mm., Barrande's fig. 14; and *A. glabra*, 16 to 17 mm.

and 16) in being oval and not circular, and the upper angle of the valve is more acute than in *A. Wilsoni*.

Measurements: |, 25 mm.; —, 13 mm.; _/, 10 mm. at 45°; ,_, 14 mm.; I, 10 (?) mm; ∨, 90°. Proportion: width to length as 26 to 35. It is larger and more oval than *A. ovata*, Pl. XV, figs. 4 and 5.

In hard black shale. Upper Silurian (Wenlock Shale); Pencarreg, Caermarthenshire, South Wales. Coll. J. E. Lee. Brit. Museum. I, 1150.

10. Aptychopsis subquadrata, sp. nov. Plate XV, fig. 20.

Mounted on the same tablet, and presumedly from the same locality as *A. angulata* (*infra*, Pl. XV, fig. 19), but in a different matrix, is a slightly convex cast of a suborbicular, or apparently subquadrate shield, with a relatively long dorsal suture and a short notch; and somewhat squeezed laterally. It is in a brown, fine-grained sandy mudstone, full of hollow impressions of minute fossils (Encrinital, &c.). Concentric lines, indicated on the cast, are rather broad and irregular. This differs markedly from fig. 19, and indeed from any other form we have met with. We must therefore regard it as a new species, and we propose to call it *subquadrata*.

Measurements: |, 7 mm.; —, 5 mm.; △, 3 mm. at 45°; ⌒, 4 mm.; I, 3 (?) mm.; ∨, 90°. Proportion, width and length equal.

From the Lower (?) Silurian; Cloncannon, Tipperary, Ireland. Mus. Geol. Survey, Ireland.

11. Aptychopsis angulata (*Baily*, 1860). Plate XV, fig. 19, and figs. 13 ? and 17 ?.

Cucullella angulata, *Baily*. Explan. Sheet 135, Geol. Surv. Ireland, 1860, p. 13, fig. 4 (woodcut).

Aptychopsis glabra (?), *T. R. J. and H. W.* Report Brit. Assoc. for 1884 (1885), p. 91.

This somewhat convex specimen and its hollow counterpart occur in the bed-plane of a thin, brownish, hard, fine-grained sandy mudstone from Tipperary, Ireland. It was figured as *Cucullella angulata* by the late W. H. Baily in the 'Explan. Geol. Survey Ireland,' Sheet 135, 1860, as noticed by us in the 'Report Brit. Assoc. for 1884' (1885), p. 91. The valves are represented by brown stains. The concentrics are distinct, rather numerous, and irregular in strength.

The outline of the complete carapace seems to have been a somewhat oblate circle, that is, widened transversely. It is not nearly so truly discoidal as *A. glabra* or *A. Wilsoni*, from which its oblateness, resulting from greater transverse width, separates it.

Measurements: |, 7 mm.; —, 7 mm.; △, 6 mm. at 40°; ⌒, 9 mm.; I, 5 (?) mm.; ∨, 100°. The width of the whole carapace to its length was probably as 14 to 12.

From the Lower (?) Silurian beds at Cloncannon, County Tipperary, Ireland. Mus. Geol. Survey Ireland.

There are two other carapaces, probably oblately circular in shape, when perfect, which approach *A. angulata.*

Pl. XV, fig. 13, consisting of one perfect and one imperfect valve, has been somewhat shortened by crumplings, induced by pressure at right angles to the dorsal axis. It may, therefore, have been more nearly circular, like *A. glabra.* No trace of concentrics remain on the disturbed and somewhat pyritous surface.

Measurements at present: |, 7 mm.; —, 8 mm.; ∠, 5 mm. at 45°; ⌒, 8 mm.; I, 5 mm.; ∨, 90°. The apparent proportion of the width of the whole carapace to its length is as 16 to 12.

In black, finely micaceous shale. Streamlet, Craigdasher Hill, 4 miles W. of Dunscore, Dumfriesshire. Mus. Geol. Survey Scotland. M 4516.

Pl. XV, fig. 17, consists of two valves flattened and distorted by oblique pressure, and represented by rusty films, with numerous concentrics almost regular in width.

Measurements: |, 14 mm.; —, 12 mm.; △, 6 (?) mm. at (?); ⌒, 9 (?) mm.; I, 5 (?) mm.; ∨ (?). The proportion of width to length of the perfect carapace was probably about 24 to 19.

In grey mudstone, dark-grey at heart, very finely micaceous, much squeezed, having its fossil-bearing plane (the bed is one inch thick) at an angle of 50° with the cleavage-plane. From the Brathay (Lower Coniston) Flags, Nanny Lane, Troutbeck, Windermere; collected by Mr. J. E. Marr, F.R.S. Woodwardian Mus., Cambridge.

It is referred to in the 'Geol. Mag.,' 1884, p. 355; the 'Report Brit. Assoc. for 1884' (1885), p. 92; and the 'Catalogue of Type Fossils in the Cambridge Museum,' 1891, p. 134.

12. Aptychopsis oblata, sp. nov. Plate XV, figs. 18, 21, 23.

Some extremely oblate, or quite transversely oval, carapaces have now to be noticed.

Pl. XV, fig. 21, has two valves each semi-elliptical transversely, together making an oval, with a broad shallow notch between them anteriorly. The angles below the notch retain a particular convexity, bounded by a distinct furrow parallel with the almost obliterated usual concentric lines of growth, which seem to have been of irregular widths, and to have ended at the outer margin with a flattish rim. The central umbonal convexity in each valve looks like the area of a certain stage of growth defined by some altered conditions of existence, as in the valves of many Lamellibranchiate Molluscs.

The measurements are |, 16 mm.; —, 15 mm.; ⧹, 10 mm. at 35°; ⌒, 11 mm.; I, 5° (?) mm.; ∨, 110°; width of carapace to its length, as 30 to 21 (about).

The two counterparts of this specimen occur in dark-grey, hard, shaly flagstone. Valves, black films.

Balmangan Bay, west side of Kirkcudbright Bay. Mus. Geol. Survey Scotland. Marked B 135 D; 2/13/4/92.

Pl. XV, fig. 18, a pair of valves belonging to a small transversely oval carapace. The two valves subreniform, having the re-entrant angle between them. They measure, |, 4·5 mm.; —, 6 mm.; ∠, 2 (?) mm. at 45° (?); ⌒, 3·5 mm.; I, 2·5 (?) mm.; ∨, about 90°. Proportion of width to length, as 12 to 7 (about).

Black films in black sub-bituminous shale; concentrics obliterated. Dobbs Linn. Mus. Geol. Survey Scotland. M 4260 c.

Pl. XV, fig. 23, a subreniform pair of valves belonging to a small transversely oval carapace. Measurements: |, 4 mm.; —, 5 mm.; ⧹, 3 mm. at 30° (?); ⌒, 4 mm.; I, 2 mm.; ∨, about 120°. The notch is half the length of the dorsal suture in depth. Proportion of width to length as 10 to 6.

In yellowish-grey shale, made up of greenish-grey and buff laminæ, very finely micaceous. Valves dark-brown films; concentrics obliterated.

Gala group; Gala Hill, Galashiels. Coll. Lapworth. British Mus. No. 59620.

X. *Genus*—Peltocaris, *Salter*, 1863.

Dithyrocaris, *Salter*. Quart. Journ. Geol. Soc., vol. viii, 1852, p. 391.
Ceratiocaris, *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, 1860, p. 161.
Peltocaris, *Salter*. Quart. Journ. Geol. Soc., vol. xix, 1863, p. 87.
— *H. Woodward*. Ibid., vol. xxii, 1866, p. 504.
— — Catal. Brit. Foss. Crust., 1877, p. 77.
— *Nicholson and Etheridge*. Monogr. Silur. Foss. Girvan,[1] vol. i, 1880, p. 210.
— *T. R. Jones*. Geol. Mag., 1883, p. 462.
— *T. R. J. and H. W.* Report Brit. Assoc. for 1883 (1884), p. 216.
— — Geol. Mag., 1884, pp. 349 and 355.
— — Report Brit. Assoc. for 1884 (1885), pp. 76 and 92.
— — Monogr. Brit. Pal. Phyllop., pt. 1, 1888, p.
— *Etheridge*. Foss. Brit., vol. i, Palæoz., 1888, p. 62.

[1] The specimen referred with doubt to this genus at p. 212 (pl. xiv, fig. 21) appears to us to belong to *Dipterocaris*, J. M. Clarke (see 'Report Brit. Assoc.' for 1884 (1885), p. 85; probably allied to *Pterocaris*, Barrande.

This Phyllopod has a discoidal, round or oval, tripartite shield, with a straight median dorsal suture, and a curved nuchal suture, which, giving way after death more easily than the other, has left in some instances a rounded, elliptical, or semi-oval cephalic notch in the shield. The separate lateral pieces of the test, instead of a straight sloping inner edge as in *Aptychopsis*, have an inner concave curve meeting the convexity of the outer margin. These two lateral moieties, however, are not so frequently found separate as is the case with *Aptychopsis*. In some instances a smaller notch appears at the bottom or apex of the curved notch, sometimes with a little escutcheon peculiar to it. The shield is smooth in all the specimens here figured. A very dubious indication of concentric striation is traceable in fig. 8.

One allied specimen has been figured and described ('Quart. Journ. Geol. Soc.,' vol. xxii, 1866, p. 504, pl. xxv, fig. 6) which has concentric lines of growth. As it represents a different species, we dedicate it to its discoverer, W. Carruthers, Esq., F.R.S.; see page 116.

1. Peltocaris aptychoides, *Salter*, 1852 and 1863. Plate XVI, figs. 1—3 and 9.

Dithyrocaris aptychoides, *Salter*. Quart. Journ. Geol. Soc., vol. viii, 1852, p. 391, pl. xxi, fig. 10.
Ceratiocaris aptychoides, *Salter*. Ann. Mag. Nat. Hist., ser. 3, vol. v, 1860, p. 161.
Peltocaris aptychoides, *Salter*. Quart. Journ. Geol. Soc., vol. xix, 1863, p. 88, fig. 1; p. 90, fig. 4.
— — *Bigsby*. Thesaur. Silur., 1868, p. 76.
— — *H. Woodward*. Catal. Brit. Foss. Crust., 1877, p. 77.
— — *T. R. J. and H. W.* Geol. Mag., 1884, p. 355.
— — — Report Brit. Assoc. for 1884 (1885), p. 92.
— — *Etheridge*. Foss. Brit., vol. i, Palæoz., 1888, p. 62.

Mr. Salter, treating of this species, describes and figures a smooth, flat, round, tripartite test, with a nuchal or rostral notch as broad as long, and of a parabolic shape, with a depth of about one-third of the whole length of the test. The umbonal angles at the inner end, or apex, of the notch are often isolated by short curved sutures (fig. 1, 1863), and sometimes lost on account of that sutural division (fig. 10, 1852). His fig. 1 has a round outline (restored ?) measuring 13 mm. each way, and the notch is 4 mm. deep and broad. His fig. 10 shows two valves united, slightly distorted by pressure, and indicating an oblately

circular test; the notch (without the innermost small notch) is 3 mm. deep and 4 mm. broad.

Pl. XVI, fig. 1. Valves obscure, black films on black graptolitic shale. From Eldinhope, Selkirkshire. Coll. Lapworth. British Museum. No. 59620.

Measurements: |, 11 mm.; —, 7 mm.; ⧍, 4 mm. at about 45°; I, 4 mm.; ⌐, 7 mm.; ∨, about 90°.

Pl. XVI, fig. 2. Valves, light-brown films on grey shale weathering brownish. From the Grieston beds of the Gala Group, at Rotten Gair, Innerleithen. Coll. Lapworth. British Museum. No. 59620.

Measurements: |, 8 mm; —, 5 mm.; ⧍, 4 mm. at 60°; I, 2 mm.; ⌐, 4 mm.; ∨, 60°.

Pl. XVI, fig. 3. Valves, black shiny films on black subbituminous shale; slightly displaced by oblique pressure. From Duffkennell, Dumfriesshire. Coll. Harkness. Mus. Pract. Geol. D | $\frac{4}{4}\frac{4}{7}$, $\frac{2}{2}\frac{2}{2}$c. This is probably the specimen figured by Mr. Salter in 1852 (pl. xxi, fig. 10); but our drawings do not quite coincide.

Measurements: |, 9 mm.; —, 6 ? mm. The sides of the notch are too much displaced for accurate measurement.

Pl. XVI, fig. 9. Valves, slightly separated, are small, black, shiny films, with minute grey bits of the smooth test. The notch is deep, but obscured by matrix. The test, when perfect, would have been round. In black shale from a burn opposite the house of a farm called Polmoody, on the road to Dobbs Linn, which is at the top of Moffat Water, about thirteen miles from Moffat. Collected by Mr. D. J. Brown, of Moffat. This is probably a young form of *P. aptychoides*.

Measurements: |, 3 mm.; —, 3 mm.; ⧍, 3? at 70°?; ⌐, 2? mm.; I, 2 mm.; ∨, 40°. Width to length as 6 to 5?

2. Peltocaris anatina, *Salter*, 1873. Plate XVI, figs. 4—9.

Peltocaris anatina, *Salter*.		Catal. Palæoz. Foss. Cambridge, 1873, p. 93 (not the figure nor the locality).
—	—	*H. Woodward*. Catal. Brit. Foss. Crust., 1877, p. 77.
—	—	*T. R. J. and H. W.* Geol. Mag., 1884, p. 355.
—	—	— Report Brit. Assoc., 1884 (1885), pp. 76 and 93.
—	—	*Etheridge*. Foss. Brit., vol. i, Palæoz., 1888, p. 62.
—	—?	*Woods*. Catal. Type Foss. Cambridge, 1891, p. 136.

In 1873 (op. cit.) Mr. Salter mentioned this species, but it was not figured. The diagram annexed to it, and given in illustration of the generic type, is *P. aptychoides*. That a *Peltocaris* was intended here is evident from the words

"its semi-oval rostrum is seldom found." The specimen (from Rebecca Hill) referred to in the 'Cambr. Catal.,' 1873, p. 93, is an *Aptychopsis* (with an angular notch, see Pl. XV, fig. 2). There is, however, in the Woodwardian Museum an oval Phyllopod shield, having a semi-oval notch (Pl. XVI, fig. 5), which is thought to be such a fossil as Salter intended for his *P. anatina*, if not the specimen itself. It was collected by Mr. J. E. Marr, F.R.S., on the west side of Long Sleddale, in a graptolitic mudstone of the Coniston series.

Pl. XVI, fig. 5. The valves are here represented by delicate grey films on dark-grey shale. They have been probably somewhat narrowed by lateral pressure.

The measurements in the present condition of the fossil are: |, 6 mm.; —, 3 mm.; ⎯/, 4 mm. at 65°; ⎽⎼, 3 mm.; I, 4 mm.; ∨, 50°. The width to length as 6 to 10.

Pl. XVI, fig. 4. Valves, pyritous films in black subbituminous shale; nearly perfect, but the notch is partly obscured by overlying matrix, and somewhat restored in our figure. This has a more oval outline than figs. 1, 2, and 3; and may be referred to *P. anatina*. Probably from the Moffat shales. Coll. J. Farie. Mus. Pract. Geology. $D\frac{4}{46}$.

The measurements are imperfect: |, 9 mm.; —, 5 mm.; ⧹, 4 mm. at 65°; ⎽⎼, 4 ? mm.; I, 4 ? mm.; ∨, about 50°. The width to length as 10 to 13.

Pl. XVI, fig. 6, is a perfect test, obovate in outline, broad and round anteriorly, and rather pointed behind. Valves, shining black films on black graptolitic shale, from the Moffat series, at Whitehope Burn, St. Mary's Loch.[1] Coll. Lapworth. British Museum. No. 59620.

Measurements: |, 9 mm.; —, 4 mm.; ⧹, 3 mm. at 70°; ⎽⎼, 3 mm.; I, 3 mm.; ∨, 40°. Width to length as 8 to 12.

Pl. XVI, fig. 7. Valves, black films on black shale. Streamlet, Craigdasher Hill, four miles west of Dunscore, Dumfriesshire. Geol. Surv. Scotland. M. 4490.

Measurements: |, 5 mm.; —, 3 mm.; ⧹, 2 mm. at 70°; ⎽⎼, 2 ? mm.; I, 2 mm.; ∨, 40°. Width to length as 6 to 7 ?

Pl. XVI, fig. 8. Valves, small shining black films, on black graptolitic shale. From Garpel Glen,[2] about four miles to the west of Moffat. Coll. D. J. Brown.

Measurements: |, 5 mm.; —, 3 mm.; ⎯/, 3 mm. at 70°; ⎽⎼, 2 mm.; I, 2 mm.; ∨, 40°. Width to length as 6 to 7 ?

[1] See 'Quart. Journ. Geol. Soc.,' vol. xxxiv, 1878, pp. 265, 274, and 279.

[2] Ibid., vol. xxxiv, 1878, p. 290.

3. Peltocaris patula, sp. nov. Plate XVI, figs. 10 and 11.

Peltocaris, sp. nov., *T. R. J. and H. W.* Geol. Mag., 1884, p. 355.
— — — Report Brit. Assoc. for 1884 (1885), pp. 76 and 94.
— sp., *Woods.* Catal. Type Foss. Cambridge, 1891, p. 136.

Two small oblate shields, with the oval notch of *Peltocaris*, differ from any of the foregoing species of this genus. In their broad, transversely oval, or elliptical outline they resemble *Aptychopsis oblata*, Pl. XV, figs. 21 and 23. Their proportion of width to length is about 7 mm. to 5 mm.

Pl. XVI, fig. 10. Valves, delicate pyritous films, slightly broken by pressure and somewhat widened. In black graptolitic shale of the Moffat (Birkhill) series, from Belcraig,[1] Annandale. Coll. Lapworth. Brit. Mus. No. 59620.

Pl. XVI, fig. 11. Pyritous films of the valves of a small oblate test, similar to the above, but finely crumpled, separated, and somewhat widened by cross-pressure at right angles to the dorsal axis of the shield. In black graptolitic shale or mudstone from Skelgill Beck, near Ambleside, Westmoreland. Coll. J. E. Marr. Woodwardian Museum, Cambridge.

4. Peltocaris Carruthersii, sp. nov. Plate XVII, fig. 7.

Peltocaris aptychoides, *H. Woodward.* Quart. Journ. Geol. Soc., vol. xxii, 1866, p. 504, pl. xxv, fig. 6.
— — *Lapworth and Swanston.* Proceed. Belfast Nat. Field Club, Appendix, 1877, Table, pl. vii, fig. 24 *b* (fig. 24 *a* is apparently a broken *Discinocaris*, not a *Peltocaris*).
— — *Dairon.* Trans. Glasgow Geol. Soc., vol. vii, 1883, p. 181, pl. vii, fig. 29.

This was noticed in 1866 by Dr. H. Woodward among the fossils from the Moffat shales in Mr. Carruthers' cabinet, but it has been unfortunately mislaid. It differs from Salter's type by its bluntly oval shape and its strong concentric striation. The figure (magnified three times) given of this form in 1866 is about 12 mm. long and 10 mm. wide, with the notch 4 mm. deep and 3 mm. wide. It is somewhat like *Aptychopsis Lapworthi*, but has a rounded notch. The illustration given in 1866 being trustworthy, we propose to treat this as a distinct species, and

[1] See 'Quart. Journ. Geol. Soc.,' vol. xxxiv, p. 284.

name it after our friend Mr. W. Carruthers, F.R.S., who gave much attention to the Moffat fossils. In the table appended to his paper Dr. Lapworth refers his figs. 24 *a* and *b* to the Lower Llandovery beds of Tieveshilly near Portaferry, and Coal-pit Bay, county Down, North-east Ireland.[1]

The late Mr. M. Dairon quoted the object of his fig. 29 from Dobbs Linn, near Moffat.

5. Peltocaris? Harknessi, *Salter*, 1863.

Peltocaris? Harknessi,		*Salter*.	Quart. Journ. Geol. Soc., vol. xix, 1863, p. 89, fig. 2 (woodcut).
—	—	*Bigsby*.	Thesaur. Silur., 1868, p. 76.
—	—	*T. R. J. and H. W.*	Geol. Mag., 1884, p. 355.
—	—	—	Report Brit. Assoc., 1884 (1885), pp. 76 and 94.
—	—	*Etheridge*.	Foss. Brit., vol. i, Palæoz., 1888, p. 62.

Shape indeterminate; it may be a piece of any large Phyllopod? species: the author was uncertain as to its alliance. Graptolitic beds (of Llandeilo age), Dumfriesshire.

XI. *Genus* Pinnocaris, *R. Etheridge, jun.*, 1878.

R. Etheridge, jun., 'Proceed. Roy. Phil. Soc. Edinb.,' vol. iv, 1878, p. 167.
H. A. Nicholson and R. Etheridge, Jun., 'Monogr. Silur. Foss. Girvan, Ayrshire,' vol. i, 1880, pp. 207—209.

Carapace capable of being bent, possibly sutured along the back. Lateral pieces, found apart, in outline like the valves of a *Pinna*. Dorsal (inner) margin straight; front edge rounded (in some cases semicircular, in others elliptically rounded); ventral (outer) margin sinuous, fully convex anteriorly, sloping and partly concave posteriorly. Concentrically striate, with delicate lines following the contour of the margin and centring on a kind of umbo situate at about a third of the length of the valve from its front edge.

The inner border of the anterior third is somewhat oblique in some cases, and apparently the two valves together would open slightly from in front towards the

[1] At the top of the Middle or the base of the Upper Silurian.

subcentral umbo, but there is no direct evidence of an open nuchal notch nor of any cephalic or rostral piece to occupy it. The hinder part of the carapace had a long triangular sulcus, either floored with a thinner kind of test, easily broken so as to come apart in a line with the umbo, and leaving narrow lateral remnants, or possibly sutured. Its ally *Pholadocaris* is not sutured.

1. Pinnocaris Lapworthi, *R. Etheridge, jun.* Plate XV, fig. 24.

Pinnocaris Lapworthi, *R. Eth., jun.* Proc. Roy. Phil. Soc. Edinb., vol. iv (1878), p. 169, pl. ii, figs. 3—5.
— — *Nicholson and Etheridge, jun.* Monogr. Silur. Foss. Girvan, vol. i (1880), p. 210, pl. xiv, figs. 17—20.

Pl. XV, fig. 24, resembles the Girvan specimen as figured (1880), especially fig. 17, except that it has lost a part of the anterior rim, whilst fig. 17 has lost part of the posterior rim. In that fig., and in fig. 20, the filmy ragged edge of the posterior sulcus has been partly preserved, in fig. 17 its edge is entire, whilst in fig. 18 such a ragged selvedge passes beyond the umbo to the front margin, showing, apparently, that there was a continuous junction of the two moieties by thin material throughout the carapace. Pl. XV, fig. 24, is not altogether different in this respect, though the posterior inner selvedge (on the right-hand side of the figure) seems to have been thickened up into a wrinkled rim. It had a stronger umbo than seen in figs. 17, 18, and 19 (Girvan), but this has been crushed down, and is about the same as in fig. 20. There is no radiate ornament.

In fig. 17 (Girvan) there is an associated sharp-pointed narrow body, which has been regarded as being probably one of the tail-spines belonging to this Phyllopod.

These are from the Lower Silurian at Balcletchie, Girvan, Ayrshire. We here figure, Pl. XV, fig. 24, a specimen of the form or variety shown by fig. 17, that is, with the hinder portion less pinched in, from the Upper Silurian of Kendal.

The shield is triangular-obovate; if the two lateral pieces were complete and laid out together the length would be about 25 mm. and the width 20 mm. It is in the British Museum. I, 2952.

No Goniatites accompany these specimens.[1]

[1] The Phyllopod described as accompanying *Pinnocaris* at Girvan belongs to J. M. Clarke's genus *Dipterocaris* (1883; see our Report for 1884 (1885), p. 85). This is of Devonian age in the State of New York, U.S.A.; and, whether or not associated with Goniatites there, it is of Silurian age and without Goniatites in this country.

In the 'Geol. Mag.,' 1882, p. 388, is a foot-note referring to some points of similarity between *Pinnocaris* and *Pholadocaris* (op. cit., p. 388, pl. ix, fig. 16). The latter has in its posterior region a narrow, triangular, sunken area occupied by a thinner (?) test, without a suture. The front third, however, has a broad cervical notch, and in this and its broader outline the German *Pholadocaris* (Devonian) differs from the British *Pinnocaris* (Silurian).

XII. *Genus* Discinocaris, *H. Woodward*, 1866.

Discinocaris, *H. Woodward*. Report Brit. Assoc. for 1865 (1866), Trans. Sect., p. 78.
— — Quart. Journ. Geol. Soc., vol. xxii, 1866, p. 503; Geol. Mag., vol. viii, 1866, p. 72.
— *Bigsby*. Thesaur. Silur., 1868, p. 74.
— *T. R. Jones*. Geol. Mag., 1883, p. 462.
— *T. R. J. and H. W.* Ibid., 1884, p. 348.
— — Report Brit. Assoc., 1883 (1884), p. 216.
— — Ibid., 1884 (1885), pp. 75 and 78.
— — Monogr. Brit. Palæoz. Phyllop., pt. 1, 1888, p. 2.
— *Etheridge*. Foss. Brit., vol. i, Palæoz., 1888, p. 51.
— *Woods*. Catal. Type Foss. Cambridge, 1891, p. 136.

This Phyllopod has normally a round test, slightly conical, without a median or dorsal suture, but an anterior triangular segment is separated from the rest of the disc-shaped shield by a line of suture, and this is usually left as an empty notch. The test is concentrically striated with lines of growth, and occasionally a reticulate or a striate ornament is recognisable between them.

Prof. A. E. von Reuss has figured and described from the Alpine Trias (Raibl beds, near Hallstadt) a very similar form (*Aspidocaris*): 'Sitzberichte k. Akad. Wissensch. Wien, Math.-nat. Cl.,' vol. lv, 1867, pp. 277—281, plate, figs. 1—5; 'Geol. Mag.,' 1882, p. 386, and 1884, p. 351.

1. Discinocaris Browniana, *H. Woodward*, 1866. Plate XVI, figs. 12—19, 21—23.

Discinocaris Browniana, *H. Woodward*. Report Brit. Assoc. for 1865 (1866), Trans. Sect., p. 78; Quart. Journ. Geol. Soc., vol. xxii, 1866, p. 504, pl. xxv, figs. 4, 5 (?), 7; Geol. Mag., vol. iii, 1866, p. 72.

Discinocaris Browniana,		*Armstrong, Young, and Robertson.* Catal. West-Scot. Foss., 1876, p. 7.
—	—	*Bigsby.* Thesaur. Silur., 1868, p. 74.
—	—	*Lapworth and Swanston.* Proceed. Belfast Nat. Field Club, Appendix, 1877, p. 114, and Table, pl. vii, figs. 24 *a*, 25 *a*, and 25 *c*.
—	—	*H. N. and E.* Catal. Cambr. Sil. Foss. Pract. Geol. Mus., 1878, p. 28.
—	—	*T. R. J. and H. W.* Geol. Mag., 1884, pp. 348 and
—	—	— 351. Report Brit. Assoc., 1884 (1885), pp. 75 and 78.
—	—	*Etheridge.* Foss. Brit., vol. i, Palæoz., 1888, p. 51.

This is a circular shield-like test, closely resembling a *Discina* at first sight, but it has a section of one-sixth of its arc removed in nearly every specimen. This triangular anterior or nuchal valvular piece is crossed by concentric striæ coincident with the lines of growth on the rest of the test. The rostral notch has normally an angle of about 90°. It extends less than half the length of the shield.

The shape of these little fossils has been much modified by pressure—vertical, lateral, or oblique. In fig. 12 the shell seems to have retained its original shape; others have been widened by pressure, as figs. 15, 16, 22, and especially fig. 17; some have been obliquely squeezed, as figs. 21 and 23; and some have been narrowed by cross-pressure, as figs. 13, 14, and especially figs. 18 and 19.

A larger specimen, and apparently with the two lateral flaps or valves folded together, was figured in the 'Quart. Journ. Geol. Soc.,' vol. xxii, 1866, pl. 25, fig. 5, and described at page 503 as retaining some remains of the tail-segments with the folded shell. Unfortunately the specimen (formerly in Mr. D. J. Brown's cabinet) has been lent or given away, at all events lost, and we cannot at present learn anything more about it.

Pl. XVI, fig. 12. Black shining film on black graptolitic, finely micaceous shale. The test is almost circular and nearly perfect, but the nuchal piece is somewhat obscure, having been broken or slightly shifted, so as to leave a small open angle at the upper part of the left-hand slope of the notch. The width of the shield to the length is as 12 to 11.

From the Moffat shales of Dumfriesshire. Coll. Carruthers. British Museum. No. 58869. This is probably the specimen represented by fig. 7 (somewhat restored), 'Quart. Journ. Geol. Soc.,' 1866, pl. 25.

Pl. XVI, fig. 13. Black film on black shale from Garple Linn. It is slightly deformed by cross-pressure. Mus. Geol. Surv. Scotland. M. 4371.

Pl. XVI, fig. 14. Black film on black shale from Dobbs Linn. Deformed by pressure. Mus. Geol. Surv. Scotland. M. 4439 c.

Pl. XVI, fig. 15. A rather large specimen, but broken and widened by vertical

pressure. Black film on black graptolitic shale from Dobbs Linn. Coll. Dairon.

Pl. XVI, figs. 16 *a*, *b*. Pyritous film of a similar fossil, also from Dobbs Linn. Geol. Surv. Scotland. M 4269 c and 4270 c. Fig. 16 *a* gives M 4270 c, being the convex counterpart; and 16 *b* shows the traces of a reticulate ornament between the concentric striæ (as in *Estheriæ*, &c.), magnified forty diameters.

Pl. XVI, figs. 17, 18, and 19. These are filmy representatives of three individuals in the same schistose-graptolitic shale, squeezed, cleaved, and jointed. They have been pyritous, but are decomposed and partially ochreous; their present shapes, whether widened or narrowed, are directly due to the force which has compressed and hardened the shale, its crumplings being at right angles to the pressure.

From the Lower Footbridge, Skelgill; Graptolitic Mudstone, A Z. Coll. Marr. Woodwardian Museum, Cambridge. Fig. 19 is referred to in the 'Report Brit. Assoc. for 1884' (1885), p. 94, and 'Geol. Mag.,' 1884, p. 351, as *Discinocaris*, sp. nov.; and in the 'Catal. Type Foss.,' Cambridge, 1891, p. 136, as *Discinocaris*, sp., from the Coniston Mudstone, Skelgill Beck, Ambleside.

Pl. XVI, fig. 21. A black, strong, shining, imperfect film, in black, finely micaceous shale (with a concave counterpart); the edges of the notch are partially overlapped by matrix, giving them a false, sinuous appearance. A fine specimen, and very slightly distorted. The width was probably about 20 mm., and the length about the same. From the Birkhill shales of the Moffat Series at Dobbs Linn. Coll. Lapworth. This is the same specimen as fig. 25 *b*, pl. 7, 'Proceed. Belfast Nat. Field-Club,' Appendix, 1877.

Pl. XVI, figs. 22 *a* and *b*. Delicate pyritous film on black, finely micaceous, graptolitic shale. Much distorted by vertical pressure (another like it lies on the same bed-plane). Fig. 22 *b* (magnified forty diameters) gives the sub-reticulate and vertically-barred interstitial ornament, like some sculpturing seen among the *Estheriæ*. From Polmoody (see above, p. 114). Coll. D. J. Brown.

Pl. XVI, fig. 23. A rather large, but distorted, pyritous film, imperfect. From the same graptolitic black shale at Dobbs Linn. Coll. D. J. Brown.

2. Discinocaris ovalis, sp. nov. Plate XVI, fig. 20.

This is a small form, with the usual concentric striæ, a narrow and deep notch, extending to almost half the length of the test, and a neat oval outline, apparently well preserved, with the wedge-shaped anterior piece in place. Delicate greyish film (once pyritous).

Measurements: |, 6 mm.; —, 3 mm.; ⧹, 4 mm. at 65°; ⌐, 2 mm.; I, 4 mm.; ∨, 50°.

From the black, graptolitic, finely micaceous shale of Dobbs Linn. Coll. D. J. Brown.

3. Discinocaris undulata, sp. nov. Plate XVI, figs. 24 *a*, 24 *b*.

This is a large subcircular or subquadrate test (imperfect). As the edge of the more perfect side is flatter than in *D. Browniana*, and the anterior edge is nearly straight, being only slightly curved outwards, the shape is almost subquadrate. The nuchal wedge is clearly evident. The concentric markings consist of broad undulating bands (about seven on a side), with mere traces of fine striæ here and there parallel among them (not shown in the drawing). Interstitial ornament (fig. 24 *b*, magnified forty diameters) is present as an obscure reticulation.

Dr. Lapworth's figure of *D. Browniana* in the 'Proc. Belfast Nat. Field-Club,' Appendix, 1877, pl. 7, fig. 25 *b*, is somewhat undulate, but with fewer bands, and our fig. 21, Pl. XVI, represents it better. There is also a figure given by the late Mr. James Dairon in the 'Trans. Geol. Soc. Glasgow,' 1883, pl. vii, fig. 32, which has an apparently undulate surface, but the bands are too broad and too few, and there is a median suture, making it an *Aptychopsis*.

Pl. XVI, figs. 24 *a*, *b*. A dull black film on the usual black graptolitic shale. Garpel Burn. Coll. D. J. Brown.

Measurements: |, 10 (?) mm.; —, 9 mm.; △, 7 mm. at 45°; ⌓, 6 mm.; I, 6 mm.; ∨, 90°. Width 18 mm. to length 16 (?).

4. Discinocaris gigas, *H. Woodward*, 1872. Plate XVII, figs. 1, 2, 3, 4 (?), and 5.

Discinocaris gigas, *H. Woodward*. Geol. Mag., 1872, p. 564; Report Brit. Assoc., 1872 (1873), p. 323.
— — *T. R. J. and H. W.* Geol. Mag., 1884, pp. 349 and 351.
— — — Report Brit. Assoc., 1884 (1885), pp. 75 and 80.

A subtriangular fragment of a Phyllopodous shell, showing delicate, concentric, parallel lines (fig. 1), was referred in 1872 by Dr. H. Woodward to a *Discinocaris*, possibly "seven inches in diameter." This was from the Moffat graptolitic shale at Dobbs Linn, Dumfriesshire. It is in the British Museum; also an oblong fragment with fine parallel lines (fig. 4). Some flattened relics of four body-rings, 45 mm. in transverse width, and varying from 5 to 10 mm. fore and aft at present, from the same beds at Ettrickbrigend, Selkirkshire (fig. 5), are in the same collection.

At Cambridge two fragments of the same large kind of carapace (fig. 2) are in the University Museum, from the Coniston mudstone of Skelgill Beck, Ambleside. Collected by Mr. J. E. Marr, F.R.S.

The late Mr. James Dairon, F.G.S., of Glasgow, kindly sent us a sketch (fig. 3) of a fine specimen of this *Discinocaris*, found by Mr. William Brown (of Birkhill, Dumfriesshire) in the graptolitic shales of Dobbs Linn, Moffat. It has somewhat the outline of the bottom of a horse's hoof, boldly curved on one edge, and broadly indented with a shallow triangle on the other. It has been much more convex than it is now, being somewhat crushed, and radiately cracked towards the curved margin. The figure measures 3 inches (73 centimetres) transversely from one side of the curve to the other, and about 2 inches ($5\frac{1}{2}$ centimetres) from the apex of the triangular indentation to the opposite edge. The sides of the notch, about 25 mm. long, slope at 15°, and the angle of the notch is 150°.

Pl. XVII, fig. 1. An iridescent, pyritous film, on a bed-plane of black graptolitic shale from Dobb's Linn, hard and finely micaceous, with ferruginous joints. This is a left-hand posterior corner of a test like fig. 3, except that the hinder border was straighter than in Mr. Dairon's sketch, reproduced as fig. 3; and the concentric lines are more closely set towards the margin. Coll. Lapworth. Brit. Mus. No. 59620.

Pl. XVII, fig. 2. A pyritous film of a crushed portion of the posterior corner of the right side on black, graptolitic, finely micaceous, shale, hard, squeezed, thick, and jointed. Graptolitic mudstone, A. Z.; Skelgill Beck, at the lower footbridge. Fig. 2 is taken from the convex counterpart of the split specimen. Coll. Marr. Woodwardian Museum, Cambridge.

Pl. XVII, fig. 3. Copy of Mr. Dairon's sketch of a large unique specimen. Evidently once subconical, but flattened by pressure. The measurements are stated above. The dotted outline gives the probably correct shape of the test without its nuchal piece.

Pl. XVII, fig. 4. An iridescent film, once pyritous, on the usual black graptolitic shale of the Moffat series at Dobbs Linn. The figure is taken from the convex counterpart. The straight edge is formed by a joint, whilst the other or smooth convex edge, against which the parallel striæ abut, may possibly be a portion of the edge of the nuchal notch of a very large individual, the fragment being 30 mm., and the whole length of such an edge on the notch of fig. 3 is only 25 mm., with the striæ meeting it at a considerable angle instead of being straight as in fig. 4. Coll. Lapworth. Brit. Mus. No. 59620.

Pl. XVII, fig. 5. A greyish film, once pyritous, on the counterparts of thin Moffat shale mentioned above at p. 122. May be regarded as body-segments belonging to *D. gigas*. Coll. Lapworth. Brit. Mus. No. 59620.

Caudal Appendages.

1. Ceratiocaris? Plate XVII, fig. 8.

Of this thin, tapering, fluted style (urotome) or stylet (cercopod), there remains a portion about 29 mm. long. It apparently consists of a dark-brown chitinous substance, nearly of the size and proportions of the urotome in fig. 4, Pl. II, Part 1, 1888, of *Ceratiocaris Halliana*. Without more definite evidence, however, it is not possible to refer it to any special genus.

It is embedded in a hard dark-grey shale of the Riccarton Beds (Upper Silurian), Shankend, Hawick. Coll. Lapworth. British Museum. No. 59620.

A larger specimen (style and stylet), also from the Moffat series, is figured and described in Part 1, p. 45, Pl. XI, fig. 13, as associated with *Aptychopsis*, but probably belonging to *Ceratiocaris*.

2. Ceratiocaris? Plate XVII, fig. 12.

This small, sharp, blade-like body, in the squeezed graptolitic shale of Skelgill, Westmoreland, is longitudinally striated or minutely fluted. It has the shape of a cercopod of one of the small species of *Ceratiocaris* shown in Pl. XI of Part 1 (1888); but those stylets are all *smooth*. It may be the terminal fragment of a rather broad and fluted style, like that of fig. 7 in Pl. XI; but there is nothing to prove a relationship to the *C. papilio* there figured. Coll. Marr. Woodwardian Museum, Cambridge.

3. Caryocaris? Plate XVII, figs. 9—11.

The schistose mudstone of the Nantlle Tramway, near the Sciont, Carnarvonshire, from which these little fossils have come, contain many specimens of *Caryocaris;* but no other Phyllopods have been found in it. Therefore at first sight these little species would seem to be referable to the genus (see above, p. 89), were it not that a *Caryocaris Wrightii*, retaining its caudal appendage, has been found by Prof. Malaise at Huy in Belgium (woodcut, fig. 6, p. 91). In this case the style and stylets are, all three, dagger-shaped, and not long, thin, tapering spines like Pl. XVII, figs. 8—10. If these last do not belong to some form of the associated *Caryocaris*, we must wait for further evidence of their relationship. They are apparently near akin to Pl. XVII, fig. 7, described above.

Figs. 8, 9, and 10 were collected by Mr. J. E. Marr, F.R.S., and are in the Woodwardian Museum.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1898.

LONDON:

MDCCCXCVIII.

A MONOGRAPH

OF THE

BRITISH PALÆOZOIC PHYLLOPODA

(PHYLLOCARIDA, PACKARD).

BY

PROF. T. RUPERT JONES, F.R.S., F.G.S., &c.,

AND

DR. HENRY WOODWARD, F.R.S., F.G.S, &c.

PART III.

DITHYROCARIS.

PAGES 125—176; PLATES XVIII—XXV.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1898.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

PART III.

DITHYROCARIS.

I. INTRODUCTORY REMARKS.

It will be seen in our list of synonyms at pp. 129, 130 that the genus *Dithyrocaris*, first known and named as *Argas* in 1835, and frequently mentioned by geologists subsequently, has had its features and structure described chiefly by J. Scouler, J. E. Portlock, F. M'Coy, H. Woodward, R. Etheridge, jun., James Hall, and J. M. Clarke; whilst F. A. Römer, Ludwig, Meek and Worthen, and Scudder have noticed some fragmentary portions, chiefly of the caudal extremity.

So many of the known remains of this genus have been found in the Carboniferous strata of the West of Scotland that it is advisable to have before us, for easy reference, a classified list of the localities there, and the geological horizons, from which the specimens have been obtained. The following list of the local formations and the species found in them has been made with the help of Dr. John Young, F.G.S., of the Hunterian Museum, Glasgow.

A List of the Species of Dithyrocaris *and allied genera, with their Localities in the Carboniferous Formations of Scotland and elsewhere.*

In the Upper Limestone series:

Chœnocaris tenuistriata (M'Coy). Settle, Yorkshire; also Belgium.

— *Youngii*, sp. nov. Lingula-shale, Robroystone, near Glasgow.

Dithyrocaris testudinea, Scouler. Cement-Limestone, Orchard, Glasgow.

In the Middle Coal and Limestone series:

Dithyrocaris tricornis, Scouler. } Ironstone pits, Inkermann, near

— *testudinea*, Scouler. } Paisley.

In the Lower Limestone series :

Dithyrocaris glabra, Woodward and Etheridge. Calderwood Cement-Limestone, East Kilbride.

— — W. and E. Shales above the First Calmy Limestone, Raes Gill, Carluke.

— *ovalis* — } Shale above the Calderwood Cement-
— *granulata* — } stone, East Kilbride.

— *testudinea*, Scouler. Shales above the Main Limestone and Lingula-limestone; and shale above Calderwood Cement-Limestone, East Kilbride district.

— — — Shale over the Main Limestone, Raes Gill, Carluke.

— — — Shale over the Hosie Limestone series, Campsie.

— — — Shales over the Main Limestone, Lickprivick, East Kilbride.

— — — Yoredale Beds, Congleton Edge, Cheshire.

— *tricornis*, Scouler. Shale above the Calderwood Cement-stone, East Kilbride.

— — — Yoredale Beds, Redesdale.

— *Colei*, Portlock. Lower Carboniferous shales, Clogher, Tyrone; Ballynascreen, Londonderry.

— — — Craigenglen, in strata under the Main Limestone series, Campsie.

— — — Calciferous Sandstone group, Tweeden Burn, near New Castleton, Roxburghshire.

— *orbicularis*, Portlock. Lower Carboniferous shales, Ballynascreen, Londonderry.

— *funiculata*, sp. nov. Calciferous Sandstone group, Tweeden Burn. Also Tyrone.

— *Scouleri*, M'Coy. Lower Limestone shale, Aghmaglogh, Clogher, Tyrone.

— — — Cement-stone group, Tweeden Burn.

— *insignis*, sp. nov., and var. *multijugata*, nov. Millstone-grit series, Eccup, near Leeds.

Dithyrocaris Belli (Woodward). Devonian, Gaspé, Canada.

Calyptocaris striata (Woodward). Lower Carboniferous, Carmichael Burn, Lanark.

Chœnocaris ? Richteriana, sp. nov. Devonian, Saalfeld.
Hibbertia orbicularis, sp. nov. Burdiehouse, Scotland.

Tail-pieces :

Dithyrocaris lateralis, M'Coy. Mountain-limestone, Derbyshire.
— — — Cement-stone group, Tweeden Burn.
— *Dunnii*, sp. nov. Yoredale Beds, Redesdale.
— — Calciferous Sandstone group, Harelow Hill Quarry, Penton, Cannobie.
— *Neilsoni*, sp. nov. Shales, East Kilbride. (See Note.)
— sp. Calciferous Sandstone group, Leatwater, below Hirzel, Coldstream.

Gastric teeth (separate or in place) : Dolly Quarry and Cowden's Quarry, Dunfermline ; Orchard Quarry, near Glasgow ; Hosie Limestone series, Campsie ; Ardross, Fife ; East Kilbride ; Scaterau, Dunbar ; Eccup, Yorkshire ; Congleton Edge, Cheshire ; Yoredale series, Redesdale ; Newcastle-on-Tyne ; and Tyrone, Ireland.

The Calderwood Cement-stone (of the Lower Limestone group) is worked at Calderside and East Kilbride, at the Kirktonholm and Glebe quarries and elsewhere. It has there an average thickness of about two feet. It is regarded as the equivalent of the First Kingshaw Limestone of the Lower Carboniferous Limestone group of the Carluke district. The Cement-stone near East Kilbride is succeeded in descending order by three limestones, locally known as Third, Second, and First Calderwood Limestones, with their intervening and accompanying shales, certain of which have proved to be very fossiliferous, especially that between the two lowest limestones (Nos. 2 and 1) of the section.

The Cement-stone is known by other local names in the Carluke district, as at Hallcraig Bridge on the left bank of Jock's Burn, where the Lingula-Limestone and Shales of the Lower-Limestone series occur. There are also localities along with the Raes Gill Ironstones, Carluke.

For convenience of reference we give the following table of the Formations.

Note.—The specimens marked "Shales, East Kilbride," in Mr. Neilson's and other collections, are from shales in connection with the Calderwood Cement-stone. Nearly all are from the shale lying over that limestone. Specimens of *Dithyrocaris* are very rare in the limestone and the shale below, which differs considerably from the overlying shale. The exposures are only a few hundred yards apart. It has been observed that, although the carapaces are well represented in this shale, there are but few teeth found at East Kilbride ; and that where separate teeth occur carapaces seem to be absent. Probably diverse currents may account for this fact.

Table of the Geological Horizons and some of their Localities in Western Scotland.

PERMIAN.				
CARBONIFEROUS SYSTEM.	CARBONIFEROUS LIMESTONE SERIES.	7. Upper Coals and Ironstone		Ell Coal, Rutherglen.
		6. Millstone-grit or Moor-rock.		
		5. Upper Limestone Group		Auchenbeg. Lesmahagow. Orchard and Robroystone, near Glasgow.
		4. Middle Limestone Group or Lower Coal and Ironstone Group		Possil Ironstone. Edge Coal series. Inkermann Ironstone pits, near Paisley.
		3. Lower Limestone Group		Calderwood, East Kilbride. Raes Gill, Carluke.
				Hosie, Campsie, Hurlet, Main, and Craigenglen Limestones.
	CALCIFEROUS SANDSTONE SERIES.	2. Upper or Cement-stone Group		Ardross, Fife. Kirktonholm Works, Glebe Quarry, &c., East Kilbride District. (Burdiehouse, near Edinburgh.)
		1. Lower or Red Sandstone Group		Carmichael Burn, near Lanark.
OLD RED SANDSTONE.				

Besides the large series of specimens of *Dithyrocaris* in the British Museum (Natural-History Branch) we have had opportunity given to us by the Keepers of other Museums, and by private individuals, of studying their many valuable collections in Scotland and elsewhere. For this we sincerely thank Sir A. Geikie, Director of the Museum of Practical Geology and the Geological Survey; Prof. T. McKenny Hughes, Keeper of the Woodwardian Museum, University of Cambridge; the Trustees of the Griffith Collection, Dublin; Dr. R. H. Traquair, Director of the Edinburgh Museum of Science and Art; Messrs. B. N. Peach and J. G. Goodchild, of the Geological Survey of Scotland; the Trustees of the Andersonian Museum, Technical College, Glasgow; Dr. John Young, of the Hunterian Museum, Glasgow; Mr. James Neilson, of Glasgow; Mr. R. Dunlop, of Airdrie; Mr. J. Dunn, of Redesdale; Mr. E. J. Garwood, F.G.S., Trinity College, Cambridge; Mr. P. F. Kendall, F.G.S., Leeds; Dr. W. Hind, F.G.S., Stoke-on-Trent, and others who have favoured us with replies to inquiries, and with other useful information.

Dr. Scouler's original specimens have been lent by the Trustees of the Andersonian Museum; some of J. E. Portlock's type-specimens have been studied among those lent from the Museum of Practical Geology; the specimens described in 1871–4 by Woodward and Etheridge, jun., are included in the Collection of the Geological Survey of Scotland; and other rare and valuable fossils have been confided to our care by Prof. McKenny Hughes, Dr. Traquair, and the other kind helpers named above.

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Dithyrocaris, Lesley, 1889. 'Dictionary Foss. Pennsylv.,' p. 212.
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Mesothyra (*?*), J. M. Clarke, 1893. 'American Naturalist' (September), p. 796.
Dithyrocaris, J. Neilson, 1894. 'Trans. Geol. Soc. Glasgow,' vol. x, p. 71.
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Dithyrocaris appears to be a Phyllocarid having for the most part a nearly flat or somewhat convex test, subcircular, suboval, or suboblong in shape, composed of two subconvex lateral halves or valves, which meet in the middle along the dorsal line at a very obtuse angle in the clypeiform specimens, but at a

higher angle in some that may be bivalved. The hinge-line is simple, and the valves easily separated.

Besides a dorsal (middle) ridge, appertaining to both valves, each valve has a median ridge (the *mesolateral*). Generally a pair of short sigmoidal rugose ridges occur on the *cephalic* or *gastric* region, and another small pair further back and nearer to the dorsal edge (the *nuchal ridges*). Another ridge is sometimes present, near to and parallel with the dorsal on each valve (the *juxta-dorsal ridges*).

In shape the tests vary from orbicular to suboblong, and the valves from suboblong to semicircular. Each valve has usually a slight projection on the curvature of its anterior edge. A neat fringe, or occasionally a cord-like border, of oblique striæ, pointing backwards, ornaments at least a part of the convex outer (*ventral*) border; and this edge, curving backwards, is prolonged over and beyond the posterior border in a strong sharp spine or spike. The extreme verge of this border was turned downwards or inwards.

In some tests there is good evidence that the dorsal or central junction-line is overlapped by a rugose ridge of minute angular imbricating flakes of shell-matter, forming plicæ or wrinkles (just as in the other ridges), and ending in a strong triangular point. In one or more folded specimens and in some separate valves this middle ridge, bearing an obliquely spinous fringe, lies on its side, and thus shows its crest. This dorsal ridge is seen in some specimens to lie evenly with the moieties, but in others clearly to override the two dorsal edges placed in apposition beneath it, and not to lie between them as in the figures and description of *Mesothyra* by Hall and Clarke, 'Nat. Hist. New York Palæont.,' vol. vii, 1888.

The surface of the two valves or moieties may be smooth, punctate, or granulated; and some are traversed by oblique wavy lines (analogous to lines of growth). Interstitial sculpture is also present. Some allied forms bear thin longitudinal ridges. In many instances abdominal segments and a trifid caudal appendage are present. Gastric teeth frequently occur, sometimes in their place in the cephalic region, but more often free and scattered in the shales.

It has been observed in the 'Geological Magazine,' vol. viii (1871), p. 106, that "it is exceedingly difficult to decide whether this form [*Chœnocaris tenuistriata*] had its valves widely expanded, as in the recent *Apus*, and probably in the fossil *Dithyrocaris Scouleri;* or whether, as in *Nebalia* and *Ceratiocaris*, they were folded down upon the sides of the animal's body. The distinction seems to be an important one; but the frequent occurrence of the united expanded valves of *Ceratiocaris* in the Upper-Silurian shales of Lesmahagow often renders it difficult to decide as to the actual and normal degree of expansion or of folding down of the lateral borders of these crustacean shields during the lifetime of the animal."

The partially open or not quite closed carapace of *Chœnocaris Youngii*,

Pl. XXII, fig. 1, looks as if a bivalved test were kept from closing by the intervention of the shaly matrix; but it may have been habitually more or less open or gaping. The ventral margin of *Dithyrocaris* seems to have stood out free from the valves in some specimens, being, as noticed by others, obliquely striate on the upper surface and longitudinally striate below; and this free edge is folded in under the margin in some instances, Pl. XXVII, fig. 5. In *Chœnocaris* it seems to be limited in width, and to remain at right angles with the valve to form a rabbeting joint with the other valve, Pl. XXI, fig. 11, and Pl. XXII, fig. 1 *d*, if closed.

The chief features to be noticed on the carapace-valves are—

1. Anterior process or spine.
2. Posterior process or spine.
3. The middle or *dorsal* ridge and its flanges.
4. The *juxta-dorsal* ridges.
5. The middle-lateral (*mesolateral*) ridges.
6. The *cephalic*, *gastric*, or *ocular* ridges.
7. The *nuchal* ridges.
8. The anterior and posterior notches or medial indentations.
9. The antero-dorsal and postero-dorsal notches.

As far as at present known the allied genera comprise the following forms, and perhaps others to which the various caudal appendages and gastric teeth may have belonged :

With meso-lateral ridges.

With a dorsal ridge. (*Dithyrocaris.*)

- Overriding—1. GLABRA .....smooth, with slight mesolaterals.
- ? 2. OVALIS..... } Granulated; with stronger meso-
- Overriding—3. GRANULATA ... } laterals.
- Overriding—4. TESTUDINEA ...with transverse lines
- ? 5. SCOULERI .....smooth
- ? 6. FUNICULATA ...slightly reticulate
- ? 7. INSIGNIS .....sinuato-reticulate
- Overriding—8. COLEI ..... } with weak juxta-dorsals } sharp granules, reticulation, and pits.
- ? 9. ORBICULARIS
- Overriding 10. TRICORNIS ...

Without a dorsal ridge ?.....11. BELLI .....multilineate and reticulate

Without a dorsal ridge. Gaping bivalve. (*Chœnocaris.*)

- 12. TENUISTRIATA multilineate and reticulate
- 13. YOUNGII.....smooth
- 14. ? RICHTERIANA costulate

} With juxta-dorsals

Without a dorsal ridge. Closed bivalve. (*Calyptocaris.*)

- 15. STRIATA .....multicostulate

Mostly with strong meso-laterals.

In the 'Geological Magazine,' December 2nd, vol. i (1874), p. 109, it was suggested that some of the then known species of *Dithyrocaris* showed, by the relatively deep central indentations in their anterior and posterior borders, that the carapaces in this "Group B" may have been more acutely bent down at the

sides during life, and more easily separated into two parts after life, than in the "Group A," or true *Dithyrocaris*. Thus:

Group A.	Group B.
Dithyrocaris tricornis.	*Dithyrocaris granulata.*
— *Colei.*	— *glabra.*
— *ovalis.*	— *? tenuistriata.*
— *testudinea.*	— *? Belli.*
— *Scouleri.*	

We do not think that this suggested grouping is sufficiently well founded to serve as a basis for classification.

As seen in the Table at page 132, the features which characteristically define some of the species, namely, Nos. 1—10, as truly belonging to *Dithyrocaris*, are wanting in others, which therefore must be separated from that genus.

The mesolateral ridges are present in all, in different degrees of development; but the dorsal ridge, an important feature, is absent in some (Nos. 11—15). Some differ further by the two halves of the carapace not forming a shield-like, but a bivalve test, folding down on each side, in Nos. 12, 13, and 14, though not perfectly fitting below, but remaining somewhat open; whilst No. 15, a costulated form, is symmetrically bivalved and closed up, like some Ostracoda.

Prof. R. P. Whitfield, at page 36 of the 'American Journal of Science,' vol. xix, 1880, states[1] that "the genus *Dithyrocaris*, M'Coy, is described as having three longitudinal ridges on the carapace. This feature is seen only when the two valves are pressed open, as in M'Coy's example, so as to present the appearance of one large plate, in which case the hinge-line forms the middle ridge."

This is also well shown in many of the illustrations of the present Monograph, —such, for instance, as Pl. XX, figs. 1 *a* and 3 *a*. There is, however, sometimes present another longitudinal ridge in each valve, lying near to and parallel with the dorsal ridge. This, feeble in Pl. XXIV, figs. 1 and 2, strong in Pl. XXI, figs. 8, 9, and 11, and in Pl. XXXI, figs. 8 and 9, we term the *juxtadorsal* ridge.

At first sight the presence of this ridge might seem to constitute an important difference; but it is essentially present, though weak, in *Dithyrocaris tricornis* and *D. Colei*, and strong in a variety of *D. insignis*. It is also a characteristic of *Chœnocaris tenuistriata*. It seems to be duplicated in *Ch. Richteriana*, and is recognisable among the costulæ in *Calyptocaris striata*.

In looking at the relative length of the *Style* and *Stylets* in the trifid caudal

[1] Also at p. 365 of the 'Annals New York Acad. Science,' vol. v, 1890.

appendages as supplying a distinctive character in the different species, we find that—

The Style and Stylets are of equal or nearly equal length in—

	Length of Carapace. mm.	Length of Stylets. mm.
Dithyrocaris Colei, xxiii, 1—4; xxiv, 4	85 and 95	30 and 45
— *testudinea*, xxiv, 7	37	11
— *Neilsoni*, xxix, 3 *a*, *b*, *c*	?	26
— (*Rhachura*) *venosa*, xxix, 4	?	48
— *carbonaria*, xxix, 5, 6	?	22
— *Kochi*, xxix, 7, 8	?	25
— *breviaculeata*, xxix, 9	?	15

The Stylets are shorter than the Style in—

Dithyrocaris testudinea ? xxiii, 7	27	9
— *Scouleri*, xxv, 6	37	25
— *Kayseri*	?	50

The Stylets are rather longer than the Style in—

Dithyrocaris Dunnii, xxiii, 9, 10; xxix, 1, 2	?	11?
— *glabra*, xix, 3; xxiii, 11	32	23
	43	15
— *testudinea*, xxi, 4	47	14

and longer in—

Dithyrocaris lateralis, xxiii, 5, 6	?	36
	?	42
— *testudinea*, xxi, 5; xxiii, 8; xxxi, 4	?	14
— *tricornis*, xxiv, 6	80	33
— *insignis*, xxx, 1—3; xxxi, 6	43 and 56	30?
Mesothyra oceani	140	70

and much longer in—

Mesothyra Neptuni	?	110

The measurements are so often difficult to make and unsatisfactory, on account of the frequent imperfections in the specimens, that the results obtained do not supply us with definite characteristics for the species at present catalogued. Besides the obscurity and breakage of parts there are several reasons for the apparent variations in the relative length of the caudal spines, both one with another and with the size of the carapace. Stages of growth, sexual difference, and the systematic variation of feature and character have to be taken into consideration, and the material at our command has not yet enabled us to arrive always at definite conclusions.

The carapaces and their halves are all here figured with the front end upwards and the posterior downwards. The straight edge (*dorsal* or upper) of

the right-hand valves is on the left hand in the plates, and the curved edge (*ventral* or lower) of the right-hand valves is on the right hand in the plates.

We propose to commence the descriptions with the more simple and smooth forms, and to take successively those with ridges and other surface ornamentation.

In arranging the plates and their figures we at first looked up the specimens that had been already published, and began with the apparently simplest forms. The arrangement of the drawings, however, was greatly influenced, of course, by the incoming of specimens at different times and from different sources.

Table of the Distribution of Dithyrocaris *and Allied Genera.*

			Scotland.	Ireland.	England.	Belgium.	Germany.	Canada.	U.S. America.
		CARBONIFEROUS.							
Carapaces.	1.	*Dithyrocaris glabra*, 1873, Woodward and Etheridge	×						
	2.	— *ovalis*, 1873, W. and E.	×						
	3.	— *granulata*, 1873, W. and E.	×						
	4.	— *testudinea*, 1835, Scouler	×	...	×				
	5.	— *Colei*, 1843, Portlock	×	×					
	6.	— *orbicularis*, 1843, Portlock	...	×					
	7.	— *tricornis*, 1835, Scouler	×	...	×				
	8.	— *funiculata*, 1898, sp. nov.	×	×					
	9.	— *Scouleri*, 1842 or 1844, M'Coy	×	×					
	10.	— *insignis*, sp. nov.	×	..	×				
	11.	*Calyptocaris striata*, 1871, Woodward, sp.	×						
	12.	*Chœnocaris tenuistriata*, 1844, M'Coy, sp.	...	×	×	×			
	13.	— *Youngii*, 1898, sp. nov.	×						
Tailpieces.	14.	*Dithyrocaris lateralis*, 1851, M'Coy	×	...	×				
	15.	— *Dunnii*, 1898, sp. nov.	×	...	×				
	16.	— *Neilsoni*, 1898, sp. nov.	×						
	17.	— *carbonaria*, 1870, Meek and Worthen	...	...	...	...	...	...	×
	18.	*Rhachura? venosa*, 1878, Scudder	..	.	.	...	...	...	×
Carapace—	19.	*Hibbertia orbicularis*, 1898, gen. et sp. nov.	×						
		DEVONIAN.							
Carapace—	20.	*Dithyrocaris Belli*, 1871, Woodward	...	...	...	...	...	×	
Tailpieces.	21.	— *Kochi*, 1864, Ludwig	...	...	...	...	×		
	22.	— *breviaculeata*, 1864, Ludwig	..	...	...	...	×		
	23.	— *Kayseri*, 1884, Clarke	...	...	...	...	×		
	24.	— *? Jaschei*, 1856, Römer	...	...	...	...	×		
	25.	*Mesothyra Oceani*, 1888, Hall and Clarke	...	...	...	...	...	...	×
	26.	— *Neptuni*, 1863, Hall	...	...	...	...	...	...	×
	27.	*Chœnocaris? Richteriana*, 1898, sp. nov.	...	...	...	...	×		

Note.—In our "Seventh Report on the Palæoz. Phyllop.," 1889 ('Brit. Assoc. Rep.,' 1890, p. 65), we referred to two specimens of *Dithyrocaris*, in M. Paul Lebesconte's Collection at Rinnes, from Lower Silurian Rocks, but have not yet been able to study them fully.

II. DESCRIPTION OF THE SPECIES.

1. Dithyrocaris glabra, *Woodward and Etheridge*, 1873. Plate XVIII, figs. 1, 2; Plate XIX, figs. 1—4; Plate XXIII, fig. 11; Plate XXV, figs. 1, 2.

Dithyrocaris glabra, *H. Woodward and R. Etheridge, jun.*,[1] 1873. Mem. Geol. Survey Scotland, Explan. Sheet 23, Appendix, p. 99.
— — *H. Woodward and R. Etheridge, jun.*, 1874. Geol. Mag., dec. 2, vol. i, p. 108, pl. v, figs. 4 and 5; Report Brit. Assoc. for 1873 (1874), Sect., p. 92.
— — *J. Armstrong*, 1876. Catal. W.-Scot. Fossils, p. 45.
— — *H. Woodward*, 1877. Catal. Brit. Foss. Crust., p. 73.
— — *Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249
— — *J. Coutts*, 1884–5. Trans. Geol. Soc. Glasgow, vol. vii, pp. 200 and 327.
— — *E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886, p. 64.
— — *Etheridge*, 1888. Foss. Brit., vol. i, Palæoz., p. 238.

Size.—The following are the measurements of the two half-carapaces (Pl. XVIII, figs. 1 and 2) as given in the 'Geol. Magazine,' 1874, p. 109, for pl. v, figs. 4 and 5:

	Large half-carapace (fig. 4).	Smaller half-carapace (fig. 5).
Greatest breadth	25 mm.	22 mm.
Greatest length	62 ,,	55 ,,
Length along the dorsal line	40 ,,	30 ,,
Breadth of anterior notch	10 ,,	12 ,,
Depth of anterior notch	7 ,,	10 ,,
Breadth of posterior notch	23 ,,	20 ,,
Depth of posterior notch	15 ,,	15 ,,

Specific Characters.—Valves (or moieties of carapace) elliptical; smooth except for a granulated antero-dorsal area, the granules sometimes extending over the dorsal area. Dorsal junction of the valves overridden by a rugose ridge, like a closely set row of ridge-tiles (Pl. XXV, figs. 1 and 2). Sometimes there is a faint indication of a mesolateral ridge (Pl. XIX, figs. 1 and 3).

Abdominal segments exposed, few; trifid appendage of strong style and stylets of nearly equal length (Pl. XIX, fig. 3; and Pl. XXIII, fig. 11).

[1] The joint authorship is mentioned at p. 98.

The dorsal junction of the valves was furnished with a flanged crest or ridge (Pl. XXV, figs. 1, 2), such as occurs in *D. granulata* and other forms; and though the valves appear to have been sufficiently convex (Pl. XIX, fig. 2) to have formed a bivalve carapace, there is no direct evidence of this having been the case. In its congener *D. granulata*, with which form it has much in common, the moieties are rather convex, and yet the carapace seems to have been clypeiform or Apus-like (Pl. XX, fig. 3).

Pl. XVIII, figs. 1 *a*, *b*. Mus. Geol. Surv. Scotl., F $\frac{2\,2}{1\,1}$, 4368, tablet 23, No. 11.

Size.—Length of valve, imperfect, 53 mm.; breadth of valve 25 mm.

Characters.—A flattened subelliptical left valve, imperfect by the loss of its posterior border and spine. Ventral margin elliptically curved; dorsal edge straight and simple. It has no mesolateral ridge, but a slight longitudinal undulation is formed by the compressed convexity. The apparent shading in Fig. 1 *a* is due to the thin shell being darkened by the black shale of the matrix, and it is emphasised at its border by a crack showing the black matrix, especially at an oval spot in the postero-dorsal region.

There are slight inequalities of the surface anteriorly, some of which are due to the presence of the gastric apparatus; there is an obscure nuchal ridge. The ventral border bears a fringe of closely-set, small, raised striæ, or compressed spinules, pointing outwards and backwards; they die out anteriorly, to be replaced by small marginal prickles analogous to the ends of the striæ.

The anterior process near the middle line or axis of the valve consists of a group of small spines (about six) rising from amongst an obscure lattice-work of angular scales, which die out ventrally in oblique striæ, and are replaced dorsally by scattered tubercles on the antero-dorsal sinuous curve of the valve as far as the small nuchal ridge of stronger tubercles. They are continued still further along the dorsal region as minute tubercles (especially in fig. 2), spreading out near the margin as far as the postero-dorsal notch. The margin then curves down boldly to the strong posterior spine, the lower edge of which is continuous with the curve of the ventral border.

The specimen shown by fig. 1 *a* has been described and figured in the 'Geol. Mag.,' dec. 2, vol. i (1874), p. 108, pl. v, fig. 4.

In fig. 1 *b* the surface, when the outer pitted film of shell is removed, shows a very minute reticulation with porous meshes.

From black shale, non-calcareous, Cement-stone group, Lower Limestone series; Glebe, East Kilbride. Collected by Mr. A. Paton.

Pl. XVIII, fig. 2. Mus. Geol. Surv. Scotl., F $\frac{2\,2}{1\,1}$, 4078, tablet 23, No. 12.

Size.—Length of valve 55 mm., including both the anterior and the posterior spines. Breadth of valve 22 mm.

Characters.—A semi-elliptical right valve. The surface is smooth and slightly granulated locally as in fig. 1, but the longitudinal undulation, due to compression, has given the false appearance of a mesolateral ridge; and a little fracture makes an artificial notch close to the antero-dorsal spine. The rim of the ventral margin is distinctly depressed, but accidental pressure may have caused this.

This specimen was figured and described in the 'Geol. Mag.,' dec. 2, vol. i (1874), p. 108, pl. v, fig. 5. The outline of the antero-dorsal edge somewhat differs in Mr. George West's careful photograph and lithographed figure, Pl. XVIII, fig. 2, from that given in the fig. 5 referred to above.

This was also from black non-calcareous shale in the Cement-stone Quarry at Glebe, East Kilbride. Mr. A. Paton's Collection.

Pl. XIX, fig. 1. Brit. Mus. No. 59541, No. 1.

Size.—Length of valve 57 mm., including the spines; breadth of valve 24 mm.

Characters.—A fine left valve, with general features like those seen in Pl. XVIII, figs. 1 and 2, but there is a faint indication of a mesolateral ridge[1] coinciding with the depressed convexity. The ventral region is rather crumpled or puckered up by pressure, and there are discolorations by the black matrix where the test is thin. Both the anterior and the posterior spines are present (the former not quite so perfect as shown in the figure).

From black shale, slightly calcareous. E. Kilbride. Paton Coll.

Pl. XIX, fig. 2. Mus. Sci. and Art Edin., "1883, 23, 5," No. 1.

Size.—Length of valve 60 mm., including the spines; breadth of valve 25 mm.

Characters.—Two displaced valves of a carapace. The left is shifted sideways over and partly beyond the right valve, and both retain a considerable convexity, perhaps indicative of the specimen having been bivalved rather than of having been flatly shield-shaped.

As in other specimens, the dorsal region of each valve bears numerous minute, scattered, sharp tubercles, most apparent on the right valve (lying under the other in the figure). Both the front and the hind spines are more or less evident on each valve.

From black shale, slightly calcareous. East Kilbride.

Pl. XIX, fig. 3. Mus. Sci. and Art Edin., 1883, $\frac{2}{5}\frac{3}{}$, No. 4.

Characters.—A right valve, not quite perfect, smooth, and exhibiting a faint trace of a middle line. At its hinder end are the remains of two crushed abdo-

[1] This feature seems to give a weak foreshadowing of one of the characteristics of the next species (*D. granulata*).

minal segments (ultimate and penultimate) and a caudal appendage of three stout sharp spines, smooth but finely fluted. These have a reversed position, so as to intrude into the postero-dorsal region of the valve.

The middle spine (style) is obscured at its extremity, but seems to have been about as long as the others. The lateral or outside spines (stylets) are each about 25 mm. long.

As with fig. 2. Lower Carboniferous; East Kilbride.

Pl. XIX, fig. 4. Brit. Mus. No. 59541, No. 28.

Characters.—This figure shows a smooth impression (on black shale) of the posterior ends of two valves, somewhat displaced. The fringed or serrated hinder part of the ventral border in each valve is distinctly visible. The test of two abdominal segments remains, but broken by pressure; also the proximal portions of three relatively broad caudal spines, crushed and displaced.

Size.—The penultimate segment is about 5 mm. long; the ultimate segment about 10 mm. long, and about 7 mm. broad in its crushed condition.

Black shale, slightly calcareous. Lower Carboniferous; Ardross.

This is one of the specimens of *D. glabra* exceedingly abundant at Ardross or Ardross Castle. Our friend Mr. J. W. Kirkby informs us that "Ardross" and "Ardross Castle," in Fife, refer to the same locality. The beds containing the *Dithyrocaris* and other fossils are bounded on each side by volcanic ash, so that their exact position in the Carboniferous series is rather doubtful; but they are now mapped by the Geological Surveyors as Calciferous Sandstone, and he thinks they are in that division, probably somewhere near the top.

Pl. XXV, fig. 1. Brit. Mus. 59541, No. 6.

Characters.—These two valves, squeezed sideways together, one over the other, and retaining some considerable convexity, are about 38 mm. in width (the carapace when perfect was probably 50 mm. wide and about 55 mm. long).

The dorsal edge of the right valve overlaps the dorsal region of the other valve. There is present an imperfect dorsal crest (broken at each end, but still 20 mm. long), which has been shifted so as to have its right edge between some (intruded) shale and the overlying dorsal edge of the right valve, while its left edge rests on the dorsal region of the left valve. The disturbance that the valves have suffered unfortunately hinders the former relationship of the parts to be quite so plainly understood as in the next example (fig. 2).

From black shale, slightly calcareous, East Kilbride.

Pl. XXV, fig. 2. Brit. Mus., No. 8.

Characters.—This left valve, 48 mm. long and 25 wide, has some of its dorsal crest still attached to its dorsal region. The fragment consists of the front

moiety of the ridge or crest, and begins at 2 mm. behind the nuchal ridge; it is $1\frac{1}{2}$ mm. broad, and has a relatively high, sharp, tent-like section. Its left-hand flange overlaps the dorsal edge of the valve for about $\frac{1}{2}$ mm.

This condition of the dorsal crest evidently shows that it was superposed on the two dorsal edges when they were in contact, overriding them like a ridge-tile on a house-roof.

From black shale, slightly calcareous, East Kilbride.

In a specimen of two valves overlapping (right on left, one of them 63 × 25 mm.), also from E. Kilbride, in Mr. J. Neilson's Collection, a fragment of the dorsal ridge, pushed off the junction of the valves, lies on the left valve, near its dorsal margin. In this specimen of *D. glabra*, the striæ of the postero-ventral margin are relatively few in the portion preserved, being separate and strong.

Pl. XXIII, fig. 11. Mus. Sci. and Art Edin., $\frac{21}{1}$, No. 5.

Size.—Valves 43 mm. long, 17 mm. wide; abdominal segments 13 mm., not easily separable in measurement, but probably antepenultimate 3 mm., penultimate 3 mm., ultimate 7 mm.; style and stylets about 12 mm. long.

Characters.—Two valves displaced, seemingly right valves, but probably one shows the inside of one valve and the other the outside of the other. The valve nearest the top of the figure (and lying obliquely underneath the other) exhibits a narrow, ribbon-like, flattened edge at the dorsal margin, looking like a flange of the dorsal angular ridge, but probably due merely to local pressure. The dorsal border of the overlying valve and the mesolateral ridge on each valve are not quite so clearly defined as in the drawing. Both valves had a smooth surface, which has been much wrinkled by pressure. The ventral margins in this specimen bear rather narrow fringes, and this modified feature is observable in other examples from Ardross.

Hard dark-grey shale, slightly calcareous. Lower Carboniferous; Ardross.

2. Dithyrocaris ovalis, *Woodward and Etheridge*, 1873. Mus. Geol. Surv. Scotl., F $\frac{22}{4}$, No. 4. Plate XVIII, figs. 3 *a*, *b*.

Dithyrocaris ovalis, *H. Woodward and R. Etheridge, junr.*, 1873. Mem. Geol. Surv. Scotl., Explan. Sheet 23, Appendix, p. 100.

— — *Iidem*, 1874. Geol. Mag., dec. 2, vol. i, p. 107, pl. v, fig. 1; Report Brit. Assoc. for 1873 (1874), Sections, p. 92.

Dithyrocaris ovalis,	*J. Armstrong*, 1876.	Catal. W.-Scot. Fossils, p. 45.
—	— *H. Woodward*, 1877.	Catal. Brit. Foss. Crust., p. 73.
—	— *Bigsby*, 1878.	Thesaur. Dev.-Carb., p. 249.
—	— *J. Coutts*, 1884–5.	Trans. Geol. Soc. Glasgow, vol. viii, pp. 200 and 327.
—	— *E., W., and J.*, 1887.	Rep. Brit. Assoc. for 1886 (1887), p. 64.
—	— *Etheridge*, 1888.	Foss. Brit., vol i, Palæoz , p. 238.

Size.—Length of single valves, probably 55 mm.; breadth of single valves, probably 18 mm.; breadth of the two valves side by side, probably 38 mm.

Specific Characters.—These are shown by the unique specimen here figured. It consists of two valves crushed, flat, and open; imperfect at the edges. The ventral border of each valve has left on the shale a strong impression of its thickened margin, but no ornament is visible, except that a very small portion of the postero-ventral margin of the left valve is preserved, with two or three obscure prickles pointing backwards, just at the beginning of the large posterior spine.

The surface is smooth on the ventral region of each valve; but the dorsal regions are covered with numerous little triangular tubercles, with the apex pointing backwards. A thin mesolateral ridge, very much depressed, evidently formed of minute oblique rugæ (as seen under the microscope, on the right valve), exists on each valve, dividing the ventral from the dorsal region, and reaching up to the cephalic region, where it is broken up by unequal pressure on probably the gastric apparatus. On the left valve are faint indications of some subsidiary parallel ridges.

The junction of the dorsal edges of the two valves is very obscure; they have been squeezed together, and the right valve partly overlaps the other. Its apparent edge and some longitudinal cracks simulate the relics of a middle dorsal ridge, but are deceptive.

The frontal notch seems to be neatly concave, but is somewhat obscured by fracture. There are no indications of anterior spines.

The posterior border, formed by the meeting of the curved ends of the two valves, is much broken; it seems to have had a deep mesial indentation. A portion of the postero-ventral spine of the left valve may be recognised.

From the Kirktonholm Cement-works, in black, non-calcareous shale above the Calderwood Cement-stone of the Lower Limestone Group, East Kilbride. Mr. A. Paton's Collection.

3. Dithyrocaris granulata, *Woodward and Etheridge*, 1873. Plate XVIII, figs. 4, 5 *a*, *b*, 6; Plate XIX, figs. 5, 6 *a*, *b*; Plate XX, figs. 1 *a*, *b*, 2 *a*—*d*, 3 *a*—*g*.

Dithyrocaris granulata, *H. Woodward and R. Etheridge, jun.*, 1873. Mem. Geol. Surv. Scotl., Explan. Sheet 23, Appendix, p. 99.
— — *W. and E.*, 1874. Geol. Mag., dec. 2, vol. i, p. 108, pl. v, fig. 3; and Report Brit. Assoc. for 1873 (1874), Sections, p. 92.
— — *J. Armstrong*, 1876. Catal. W.-Scot. Fossils, p. 45.
— — *H. Woodward*, 1877. Catal. Brit. Foss. Crust., p. 73.
— — *Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249.
— — *J. Coutts*, 1844–5. Trans. Geol. Soc. Glasgow, vol. vii, pp. 200 and 327.
— — *E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886 (1887), p. 64.
— — *Etheridge*, 1888. Foss. Brit., vol. i, Palæoz., p. 238.

Specific Characters.—*Dithyrocaris granulata* is very similar to *D. glabra*; but it has on each valve a definite mesial (mesolateral) ridge; and an abundant granulation on the anterior and dorsal regions. These features distinguish this species from *D. glabra*. Moreover the medio-dorsal ridge, with its side-flanges, is perhaps more strong developed. It remains attached to a valve, and perfect, in Pl. XVIII, fig. 4, and Pl. XX, fig. 2 *a*; and a portion of it overrides the two dorsal edges of an open carapace in Pl. XVIII, fig. 6, and Pl. XX, fig. 1 *a*.

Pl. XVIII, fig. 4, and Pl. XX, fig. 2 *a*—*d* (magnified). Mus. Geol. Surv. Scotl., F $\frac{32}{6}$, No. 6.

Size.—Length of valve, 40 mm., including the spines; breadth of valve, 18 mm.

Characters.—A single left valve semi-elliptical, that is, having the shape of the moiety of an ellipse that has been divided longitudinally into two halves. The dorsal edge is straight; the ventral has a symmetrical elliptical curve. The ends differ; the anterior, defined by the rising and narrowing curve of the ventral border, bears a short antero-dorsal process, above which (to the right or left in the figures) the dorsal border begins with an ogee curvature. The posterior end is more broadly curved, but turned in suddenly to meet the junction-line of the valves, so that the dorsal border ends in a medial recess. The hinder border, moreover, is marked by a strong, postero-ventral, triangular, flat, sharp spine,

with the upper edge of which the postero-dorsal curvature makes a strong angular notch.

The outer coating of the test on the ventral border has a delicately serrated margin on its posterior half or two-thirds. This is formed of oblique striæ (like minute closely-set spines), pointing backwards; but this fringe becomes narrow and dies out on the anterior part of the margin.

The dorsal edge has on its posterior two-thirds a narrow ridge of small angular rugæ, pointing backwards; and, in Pl. XX, fig. 2 *a* (magnified), this is seen to have a thin and narrow flat flange on each side; altogether constituting a narrow slip of test, seemingly at first sight intermediate to the two valves,[1] but really overlapping them at their junction; seen also in Pl. XX, figs. 1, 2, and 3.

On the surface the dorsal region of the valve is minutely punctated and bestrewn with minute tubercles, which are coarser in the antero-dorsal region; and, continued round the front of the valve, they there pass downwards and backwards for a little way in the antero-ventral region, as closely-set, parallel, oblique striæ. The ventral moiety of the valve is otherwise smooth.

A mesolateral rugose ridge, thinning away at its ends, passes along two-thirds of the surface of the valve, between the dorsal and ventral regions. It is composed of overlapping chevron-shaped flakes or scales, making transverse scale-like markings (see Pl. XX, fig. 2 *b*).

This specimen was described and figured in the 'Geol. Mag.,' 1874, p. 108, pl. v, fig. 2.

In the anterior part of the valve are two small rugose ridges; one (the "nuchal" ridge about 3 mm. long) near the front end of the dorsal edge, and parallel to it, just where the dorsal ridge ends, is thin and somewhat sinuous; the other (the "cephalic" or "gastric" ridge about 3·5 mm. long) between the nuchal and the front end of the mesolateral ridge, is more or less sigmoidal, terminating behind in a circular turn, which is either solid, or forms a small pit like an ocular spot. (The latter ridge is more persistent than the nuchal ridge, which is often obsolete or evanescent on one or the other valve in *Dithyrocaris*). All the ridges consist of apparently overlapping scales or flattened chevrons, with their angles pointing backwards. These are evidently essential elements in the leaf-ornament or lattice-work on the abdominal segments of *Ceratiocaris papilio* and *C. stygia* ('Monogr. Pal. Phyllop.,' Pal. Soc., 1888, pp. 35 and 39; but in *Ceratiocaris* the angles are set in a contrary direction to what holds good in *Dithyrocaris* (Pl. XX, figs. 2 *b* and 3 *g*).

From black non-calcareous shale in the Glebe Cement-stone Quarry, Kirktonholm Cement-works, East Kilbride. Mr. A. Paton's Collection.

[1] As in Hall and Clarke's *Mesothyra*, &c.

Pl. XVIII, figs. 5 *a*, *b*. Mus. Geol. Surv. Scotl., F $\frac{22}{11}$ and 23, No. 13.

Size.—Length of valve 32 mm., including terminal spines; breadth of valve 15 mm.

Characters.—A single left valve, rather smaller than that in fig. 4, and with a rather sharper mesolateral ridge, and the rim of the ventral margin depressed. Otherwise the features are the same as in fig. 4.

This specimen was described and figured in the 'Geol. Mag.,' 1874, p. 108, pl. v, fig. 3.

From black non-calcareous shale in the Cement-stone Quarry; Lower Limestone group, Glebe, East Kilbride, Lanarkshire. Mr. Paton's Collection.

Pl. XVIII, fig. 6; and Pl. XX, figs. 1 *a*, *b* (magnified). Brit. Mus. No. 59541, No. 9.

Size.—Length of valve 35 mm., including the spines; breadth of valve 14 mm.; breadth of the two valves 28 mm.

Characters.—A pair of valves, united along their dorsal edges. The features of each valve are as described for figs. 4 and 5. A short piece of the dorsal ridge is preserved (magnified in Pl. XX, fig. 1 *a*); and there is sufficiently clear indication of it and of its narrow lateral flanges throughout its extent on the hinder two-thirds of the dorsal region. Posteriorly the dorsal junction ends in a nearly square central notch, without any special prolongation.

In "Coal shales," black, slightly calcareous, East Kilbride. Paton Coll.

Pl. XIX, figs. 6 *a*, *b*; and Pl. XX, figs. 3 *a*—*g* (magnified). Brit. Mus. No. 59541, No. 10.

Size.—Length of carapace, probably, 40 mm., when perfect; breadth of the two valves 25 mm.

Characters.—Two valves of a carapace in apposition by dorsal attachment. Though fractured by crush on the margins and posteriorly, it retains a considerable convexity (see Pl. XX, fig. 3 *b*). The carapace has the same features and characteristics as Pl. XX, fig. 1, but it looks rather blunt in front, owing to fracture and extension by pressure there.

The two mesolateral ridges are very distinct, and the dorsal ridge is high and well preserved (see Pl. XX, figs. 3 *a*, *b*, *d*, *f*, *g*). It ends by fracture where the test is broken away behind; fig. 3 *d* shows its cross-section (magnified) and its almost tubular cavity.

The nuchal and gastric ridges are also well shown; the latter seem to end behind in ocular pits; and the former have other and irregular elevations in their vicinity, near the front end of the dorsal ridge.

From "Coal shales," black, slightly calcareous, East Kilbride. Paton Coll.

Pl. XIX, fig. 5. Mus. Sci. and Art Edin., Coutts, 1887, $\frac{25}{15}$, No. 9.

Size.—Length of valve, imperfect, 48 mm.; breadth of valve about 25 mm.

Characters.—This is a right valve, imperfect at its posterior end; though much depressed at its edges, it retains some convexity. The surface is tuberculate on the antero-dorsal and the dorsal region; but otherwise smooth and shining.

The sigmoidal cephalic ridge is nearer to the dorsal edge than usual, probably owing to some displacements in the antero-dorsal region by pressure. The dorsal edge is nearly straight, but irregularly broken. The ventral edge has the narrow fringe or neatly corded rim as usual for a great part of its extent.

The mesolateral ridge is thin, but very distinct; there are some low, irregular elevations at its front end.

In black shale, slightly calcareous, from East Kilbride.

4. DITHYROCARIS TESTUDINEA, *Scouler*, 1835. Plate XIX, figs. 7—9; Plate XXI, figs. 1—6; Plate XXII, fig. 3; Plate XXIII, figs. 7 (?), 8; Plate XXIV, fig. 7; Plate XXVII, figs. 3 *a*, *b*; Plate XXVIII, figs. 1 *a*, *b*, 2, 3 *a*, *b*, 4, 5 *a*—*c*; Plate XXIX, figs. 10—14; Plate XXXI, figs. 1—3, 4.

ARGAS TESTUDINEUS, *Scouler*, 1835. Records of General Science (Thomson's), vol. i, pp. 137, 141, fig. 3.

DITHYROCARIS TESTUDINEUS, *Morris*, 1854. Catal. Brit. Foss., edit. 2, p. 107.

— — *Salter and Woodward*, 1865. Chart Foss. Crustacea, p. 17, fig. 11.

— — ? (teeth), *J. Young*, 1868. Trans. Geol. Soc. Glasgow, vol. i, p. 58.

— — *J. Armstrong*, 1871. Trans. Soc. Geol. Glasgow, vol. iii, Appendix, p. 30; and 1876, Catal. W. Scot. Fossils, p. 45.

— — *H. Woodward and R. Etheridge, jun.*, 1873. Mem. Geol. Surv. Scotl., Expl. Sheet 23, Appendix, p. 98; and Geol. Mag., vol. x, p. 482, pl. xvi, fig. 1.

— — *J. R. S. Hunter*, 1875. Palæont. Carb. Strata W. Scotland, part ii, p. 65.

— TESTUDINEA, *H. Woodward*, 1877. Catal. Brit. Foss. Crust., p. 73.

— — *Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249.

Non DITHYROCARIS TESTUDINEUS, *R. Etheridge, jun.*, 1879. Quart. Journ. Geol. Soc., vol. xxxv, p. 465, pl. xxiii, fig. 1.

ARGUS TESTUDINEUS, *Packard*, 1883. North-American Phyllop., p. 452.

DITHYROCARIS TESTUDINEUS, *J. Coutts*, 1884–5. Trans. Geol. Soc. Glasgow, vol. vii, pp. 197 and 327.

— — *E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886 (1887), p. 63.

DITHYROCARIS TESTUDINEA, *Etheridge*, 1888. Foss. Brit., vol. i, Palæoz., p. 238.
— TESTUDINEUS, *W. Hind*, 1897. Monogr. Carbonif. Lamell., Pal. Soc., pp. 93, 94.

Specific Characters.—Carapace broad-oval, somewhat convex, and probably clypeiform (*Limus*-like); anterior notch small and angular; posterior broad with a sinuous edge (Pl. XIX, fig. 7). Posterior spines well developed; ventral marginal fringe stronger behind than in front. Dorsal junction of the two moieties (valves) simple. Mesolateral ridges strong and rugose. Cephalic and nuchal ridges and protuberances more or less evident. Surface ornamented with wavy and interrupted lines sloping obliquely backwards from the dorsal to the ventral region. Abdominal segments marked with similar and chevron-like lines; of the three caudal spines, the style is shorter than the stylets.

Pl. XXIV, fig. 7. Mus. Techn. Coll. Glasgow.

This specimen was the first-described example of those referred to *Dithyrocaris testudinea;* and is therefore here taken first in the account of the species.

Size.—Length of valve 37 mm.; length of the exposed abdominal segments, free of the valves, and the trifid tail, 20 mm.; these have been twisted so as to show their ventral aspect; longest caudal spine exposed (one of the stylets), 11 mm.

The style 10 mm. long. Breadth of the two valves 30 mm.; incomplete for want of the ventral fringe on each valve; breadth of one valve about 15 mm. without the fringe.

Characters.—A broad-oval carapace, slightly convex; somewhat damaged by pressure, but presenting its chief features (except the marginal fringe) distinctly. It has a triangular notch in front opening into a narrow cleft (caused by pressure) between the antero-dorsal regions of the valves; also a broad posterior indentation with broken edges. The valves, or lateral moieties of the carapace, are semi-elliptical, and are in apposition by their dorsal edges, but overlapping irregularly in the lower half of the dorsal region, and slightly apart in front. In each valve of this specimen the ventral border is here destitute of a marginal fringe, such as is usual in other specimens. It is uniformly simple and flattened at the edge. In both valves it ends in a small, obscure spine; and the posterior border is imperfect on account of fracture. A strong ridge, having the usual rugose structure of overlapping chevron-shaped scales, rises along the middle of each valve, intermediate to the margin and the dorsal line. There are also some irregular surface-spots in the cephalic region; but the cephalic ridge, and the place of the nuchal ridges, are traversed and obscured by local crush-fracture.

The surface of the valves bears numerous parallel, slightly raised lines, oblique and sinuous ("raised, oblique, recurved, and divaricating," *Etheridge*), passing from the dorsal to the ventral border; those reaching its hinder part are there

bent forwards. Close to the posterior angles, over a limited area, these lines are lost among small tubercles (visible in a photograph). The two moieties of the carapace together present an elegant symmetrical pattern. In each valve the lines converge at the antero-dorsal region.

The abdominal segments exposed in this specimen are much obscured by pressure; and have been so squeezed as, at first sight, to look like numerous (eight or more) very short rings (such as those in *Apus* and *Lepidurus*); and are crushed in along the middle line. This false appearance of many rings, however, is due to the relative prominence of the transverse, sinuous, overlapping lines of growth on the segments being emphasised by pressure.

The style and stylets are stout, fluted, and have traces of granulation on the riblets. They are of nearly equal length. They have had their position reversed, showing their ventral and not their dorsal surface.

Fig. 7 is from Dr. Scouler's original specimen, described by him in 1835. It is in hard black earthy limestone, from the Carboniferous Limestone series, "about a mile [1] to the east of Paisley" ('Records, &c.,' p. 136).

It was also described and figured by Woodward and Etheridge in 1873, and has been lent to us by the Trustees of the Andersonian Museum (Technical College) at Glasgow.

Pl. XIX, fig. 7; and Pl. XXII, fig. 3 (front end magnified). Brit. Mus. No. 59541, No. 15.

Size.—Length of carapace 27 mm.; breadth of carapace 20 mm.

Characters.—Carapace, with its two moieties, or pair of valves, flattened out, but in natural apposition at their dorsal margins. Damaged in the middle; it is broadly oval in outline. Indented in front by a small notch at the junction of the valves; its edges are there fringed with minute spines (Pl. XXII, fig. 3). Posteriorly each valve has a strong spine, continuous with the ventral border; and curving in between them, with two gently convex curves, the one valve meets the other in a central notch. There is a faint trace of the marginal fringe on each valve. The surface exhibits the peculiar oblique lineation of the species; also some gastric tubercles, and traces of the two mesolateral ridges.

In black shale, slightly calcareous. Probably from East Kilbride.

Pl. XIX, fig. 8; Pl. XXXI, fig. 1 (ornament). Brit. Mus. No. I.109, No. 21.

Size.—Length of valve about 50 mm.; breadth of valve about 23 mm.

Characters.—Two valves, showing their insides, displaced, but lying back to back; neither of them perfect. A part of the anterior notch is traceable. The

[1] At a place now called "Inkermann," where Mr. R. Dunlop has lately most obligingly sought for further indications of these fossils, but without success.

hinder edge of the right valve (on the left-hand side of the figure) retains its spine and part of the posterior notch. The hollow inside of a strong mesolateral ridge is distinct in each valve.

These insides show also the usual oblique lineation, due apparently to successive overlapping of the flaky tissue of the test in its growth. The spaces between the lines are pierced with close-set minute perforations (Pl. XXIX, fig. 1), individually blackened by the infilling of the black shale of the matrix. This appearance is probably due to the removal, by decomposition, of both the outer and inner filmy coatings of the test. Pl. XVIII, fig. 1 *b*, shows such a structure in the test of *Dithyrocaris glabra*, in which the removal of the delicately pitted surface-layer exposes equivalent perforations in the next layer below.

In hard grey calcareous shale. From the Lingula-Limestone at Jock's Burn, below Hallcraig Bridge, about one mile west of Carluke. Dr. Rankin Coll.

Pl. XIX, fig. 9. Mus. Pract. Geol., No. 6368.

Size.—Length of valve about 34 mm.; breadth of valve about 18 mm.

Characters.—Two valves, lying one on another; the dorsal edge of the left (uppermost) valve shifted on and beyond that of the other valve. The ventral border of the right valve (undermost) shows the serrated edge, or fringe, thinning away forwards. Bounded inside by a thin definite parallel ridge, this corresponds to the "double margin" of other species. Each valve has a mesial ridge, somewhat rugose here and there. Postero-ventral spines are well shown. The surface obliquely striated as usual.

A little obliquely sub-oblong *Posidonomya*, looking almost silky with its numerous delicate, concentric striæ, lies on the same piece of hard, grey-black, micaceous shale, non-calcareous, from the Glasgow Coal-field.

Pl. XXI, fig. 1. Brit. Mus. No. 59451, No. 17.

Size.—Length of valve 50 mm.; breadth of valve 20 mm.

Characters.—A large left valve, perfect in outline, but filmy in substance; dorsally apposed to an imperfect right valve; the junction indicated by the position of the front and hinder notches. The mesolateral ridge is rugose in its posterior portion; the ventral border retains some of its fringed outer margin, and its posterior spine.

In black shale, very slightly calcareous. From East Kilbride.

Pl. XXI, fig. 2. Brit. Mus. No. 46395, No. 18.

Size.—Length of valve 45 mm.; breadth of valve about 18 mm.

Characters.—Two imperfect valves, closely adpressed and obscurely overlapping on the dorsal border. The ventral border of the left valve has left no mark

of its fringe; but the impression of the longitudinal striæ of its under surface is present.

In "Coal-shale," black and calcareous, Carluke. Morris Coll.

Pl. XXI, fig. 3; Pl. XXXI, fig. 2 (ornament). Mus. Sci. and Art Edinb., Coutts, 1887, $\frac{2}{15}$, No. 13.

Size.—Length of valve, imperfect in front, 28 mm.; breadth of valve 15 mm.

Characters.—Right valve (or moiety of carapace) semi-elliptical; with a very thin film of the test, flattened, smooth, bearing numerous delicate, sinuous lines passing obliquely from the dorsal region to the mesial ridge, and, coinciding with the angular lines of its chevron-like rugæ; passing on to the ventral border, they are deflected forwards, as usual in *D. testudinea*. The spaces between the lines are closely pitted with very minute puncta (Pl. XXXI, fig. 2). There are the usual small sigmoidal cephalic ridge and thin short nuchal ridge; not clear in the figure.

The dorsal edge is simple; very slightly bent at the nuchal ridge, and damaged at its posterior end. The postero-ventral spine is proportionally strong; the ventral edge is fringed as far as it is clear of the matrix.

Black slightly calcareous shale. Probably from East Kilbride.

Pl. XXI, fig. 4. Mus. Sci. and Art Edinb., Coutts, 1887, $\frac{2}{15}$, No. 11.

Size.—Length of one valve (the right), including the spine, 38 mm.; breadth of valve about 18 mm.; of the abdominal segments exposed, the ultimate and part of penultimate, 10 mm.; style, 11 mm.; stylets about 15 mm.

Characters.—This specimen represents a right and a left valve and the caudal extremity, all displaced and crushed. The abdominal segments and tail have not been removed far from the posterior extremity of the left valve; and the hinder part of the right valve lies at a right angle over the postero-dorsal region of the left valve, near both of which, indeed, the caudal portion is situated. Both valves show evidences of the ventral fringe, the ridges, and the peculiar lineation of *D. testudinea*.

The abdominal (ultimate) segment that is exposed has been turned over, so as to show its lower or ventral aspect. It has rather sinuous chevron-lines crossing it, with their bluntish angles looking backwards. Of the three tail-spines the style (in the middle) is the shortest; it shows a flat, smooth surface (ventral), and probably was of a bayonet-shape. The others are much longer, convex, and striated, coarsely at top, but more delicately towards the ends. The relative position of the three spines shows that all the tail exposes the ventral aspect. The mesolateral ridge of the left valve appears, by some accident, to be much stronger (or better preserved) than that of the right valve.

A small *Posidonomya* lies in the shale near the end of one of the stylets, and another at the ventral edge of the right valve near by.

In black shale, slightly calcareous. From East Kilbride.

Pl. XXI, fig. 5; Pl. XXXI, fig. 4 (magnified). Brit. Mus. 59541, No. 27.

Size.—All the three caudal spines are imperfect at the distal ends. The longest stylet is about 30 mm.; the style 20 mm. without the head and the tip.

Characters.—This specimen shows an impression of the dorsal surface of part of the ultimate segment, and the under (ventral) surfaces of three tail-spines. The impress of the segment is smooth in appearance, but bears the characteristic chevron-lines and obliquely striated interspaces. The caudal plate at the head of the trifid is lost.

The spines are apparently smooth, but really delicately striated or ridged.

The style shows by the impress of upper (forward) part that it was striate; and its lower moiety bears a single smooth ridge on its ventral aspect, with a broad smooth furrow on each side of it. By their impressions the stylets were evidently costulate on the dorsal face, with fine, oblique, subsidiary striæ on the sides of the four or five riblets; and on the ventral face each has three costulæ, marked with delicate, close-set chevrons, pointing downwards (backwards), their side-lines making oblique subsidiary striæ. They show pits for bases of hairs.

In black non-calcareous shale; East Kilbride. There is a *Posidonomya* on the shale, small, with concentric irregular undulations.

Pl. XXI, fig. 6; Pl. XXXI, fig. 3 (ornament). Mus. Sci. and Art Edinb., Coutts, 1887, $\frac{2\,5}{1\,5}$, No. 12.

Size.—Length of valve, imperfect, 30 mm.; breadth of valve about 16 mm.

Characters.—A right valve (or moiety of carapace) imperfect in front and at the dorsal edge; more convex than fig. 3, and with thicker test; it has similar characteristic lineation and minutely punctate interspaces (Pl. XXXI, fig. 3). Ventral fringe strong in the posterior part, and narrowing forwards as far as seen.

In black calcareous shale. From East Kilbride.

Pl. XXIII, fig. 7. Brit. Mus. 59541, No. 30.

Size.—Carapace 27 mm. long, 18 mm. wide; style 10 mm. long; stylets (probably shortened by fracture) 9 mm. long.

Characters.—This small trifid tail-piece is attached to a subconvex, oval cast (not figured) of a little *Dithyrocaris testudinea*, badly preserved, but retaining its length and width, and some of the characteristic lineation, directed obliquely backwards, outside the mesolateral ridges. The details of character are rather obscure. The distal parts of the trifid have left impressions of the lower or

ventral faces on the shale, and these appear to have been sulcate, with granulations (possibly adventitious) on the median ridge. The dorsal faces have only a small portion of the top end of each preserved, showing a median ridge, and otherwise sulcate.

This may belong to a small variety or a young form of the normal *D. testudinea*.

It is comparable in size with the trifid of *Ceratiocaris minuta* of our 'Monograph Brit. Palæoz. Phyll.,' 1888, p. 47, pl. x, fig. 11, and pl. xi, fig. 10.

In black shale, non-calcareous. East Kilbride. Paton Coll.

Pl. XXIII, fig. 8. Brit. Mus. 59541, No. 29.

Size.—Penultimate segment 3 mm. long in its most perfect part. Ultimate segment 6 mm. long; style obscure; stylets 13 mm. long.

Characters.—The penultimate segment is marked with transverse wavy lines and the ultimate with oblique lines; thus comparable with *D. testudinea*.

In this small tail-piece the three spines have been pressed together, and one of them (the style) is quite obscured as to character and relative size. The two largest spines are cercopods (stylets) of equal length, and are sulcate.

This little specimen, in dark-grey calcareous shale, was collected by the late Dr. Rankin in Lanarkshire.

Pl. XXVII, figs. 3 *a*, *b*. Neilson Coll., H.

Size.—Length about 34 mm.; width about 2 mm.

Characters.—A small, delicate specimen of an isolated dorsal crest like that attached to the valve shown in Pl. XXVIII, fig. 1.

In black shale, slightly calcareous. Kirktonholm, East Kilbride.

Pl. XXVIII, figs. 1 *a*, *b*. Neilson Coll., D.

Size.—Length, including the spine, about 85 mm.; width about 37 mm.

Characters.—The right-hand moiety (magnified) of a good carapace of *D. testudinea*, having besides its usual characteristics a well-marked cristate dorsal ridge, which is absent in all the specimens hitherto described. A separate example, however, of such a dorsal ridge is also preserved in Mr. Neilson's cabinet (Pl. XXVII, fig. 3).

Black shale, non-calcareous. East Kilbride.

Pl. XXVIII, fig. 2. Neilson Coll., C.

Size.—Width at the top of the piece about 35 mm.; width between the points of the two spines 24 mm.; width between the bases of the two spines 20 mm.

Characters.—The posterior portion of a well-preserved right-hand moiety or valve of *D. testudinea*, showing the exact form of the hinder edge and the two posterior spines.

Black calcareous shale. East Kilbride.

Pl. XXVIII, figs. 3 *a*, *b*, Neilson Coll., E.

Size.—Length 13 mm.; width at top of the piece 11 mm.

Characters.—The posterior portion of the left-hand moiety of *D. testudinea*, magnified to show the characters of its ventral fringe and spine, its mesolateral ridge, and the usual obliquely curved transverse lineation. This has a very sharp mesolateral ridge. The ventral fringe seems to be broad all the way forward. Gastric tooth in place; and two, separate, in the shale.

Black shale, non-calcareous. East Kilbride.

Pl. XXVIII, fig. 4. Mus. Geol. Survey Scotland, F. $\frac{22}{10}$, No. 10.

Dithyrocaris testudineus [ea], *Woodward and Etheridge*, 1873. Geol. Mag., vol. x, p. 482.

Size.—Length 22 mm.; breadth of the valve, narrowed by lateral pressure, 8 mm.

Characters.—This left-hand half of a carapace, from shale above the Main Limestone (Lower Limestone group) in an old quarry on North Lickprivick[1] Farm, at the site of Lickprivick Castle, near East Kilbride, was described, but not figured, by Woodward and Etheridge in 1873 (*op. cit.*). Crumpled and narrowed by lateral pressure, it possesses the usual "raised, oblique, recurved, and divaricating lines" characteristic of *D. testudinea*. It shows also that "a lateral median [mesolateral] ridge (seen on each side in Dr. Scouler's specimen) marks the centre intermediate between the margin and the dorsal line of the carapace." See page 146, Pl. XXIV, fig. 7.

Pl. XXVIII, figs. 5 *a*—*c*. Mus. Sc. and Art Edinb., Coutts, 1887, $\frac{25}{15}$, No. 10.

Size.—Length of carapace 36 mm.; width of carapace 30 mm.

Characters.—This is the cast of a fairly perfect carapace, flattened out. It shows on the inside the impression of the external surface of the original test. This had very delicate, interlinear, sinuous, anastomosing striæ, obliquely transverse to the interspaces; also a minute punctation. The infilling of these little pits of the surface appears in Fig. 5 *c* as minute pimples.

Fig. 5 *b* is a magnified representation of a part of the inturned ventral margin, visible on the right-hand side of fig. 5 *a*. Compare Pl. XXVII, fig. 2, in which analogous features, in a fragment of *D. tricornis*, are seen; namely, the outside of the straight-lined rim of the inturned margin, which is flattened down on the inside of the fringe.

From East Kilbride. In black shale, slightly calcareous.

[1] The Lickprivick locality is noticed at p. 80 of the 'Catal. Western Scot. Fossils,' 1876.

Pl. XXIX, figs. 10 *a*, *b*; 11 *a*—*d*; 12 *a*, *b*; 13 *a*—*c*; 14. Neilson Coll., J.
Size :

Fig. 10.—	8 mm. long,	8 mm. wide.	A fragment.
,, 11.—11	,, 8	,,	Imperfect in length.
,, 12.—11·50	,, 6	,,	Nearly perfect in length, imperfect in width.
,, 13.— 7·50	,, 5·50	,,	A fragment.

,, 14.—Diagram of the ornament.

Characters.—These four abdominal (caudal) segments (more or less imperfect) are cylindrical, and bear chevron-lines similar to those of *D. testudinea* in Pl. XXI, fig. 4. Similar ornament is present in Pl. XXI, fig. 10, which we refer with some doubt to *D. Scouleri*.

Judging from Pl. XXI, fig. 4 (page 149), in which the ventral face is upwards, fig. 11 *a*, having the chevrons pointing downwards (backwards in the living animal), presents its under side. Its interstitial ornament (fig. 11 *b*) consists of an extremely delicate porous reticulation, with larger pores widely scattered.

Figs. 10 *a* and 12 *a*, for the same reason, must be taken as dorsal aspects. A delicately crimped edge or fringe marks the lowest part of the test of these segments just above the distal joint, to which the trifid spines were probably attached. The ornament (fig. 12 *d*) consists of the smooth raised striæ (chevron-lines) and punctate interspaces. These segments have been somewhat crushed, so that the lower end is broken (fig. 12 *b*), and the sectional area (figs. 10 *c* and 12 *c*) is suboval.

Figs. 13 *a*, *b*, retain a part of the top of the segment complete, but otherwise the specimen has been damaged at the end and side (figs. 13 *a*, *b*). The spines of the crimped edge of the test have been broken off. Figs. 13 *a*—*c* show a short cylindrical fragment.

In all of these four segments it is observable of the chevrons that those on one face point in an opposite direction to those on the other face, so that one chevron continuing on the two sides forms an elegant lozenge pattern with rather blunt angles, as shown in the diagram, Pl. XXIX, fig. 14.

In black shale. Two from Calderside; and two from Kirktonholme.

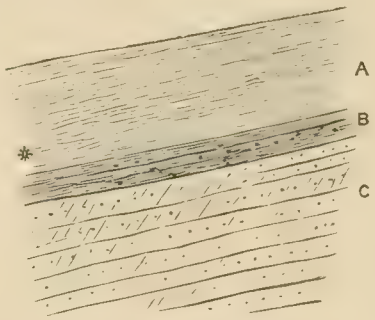
Dithyrocaris testudinea, Scouler; W. Hind, 1897, 'Geol. Magaz.,' dec. 4, vol. iv, p. 208; and 'Monograph Carbonif. Lamellib.,' Pal. Soc., p. 93.

A specimen obtained by Dr. Wheelton Hind, F.G.S., from a quarry on Congleton Edge, Cheshire, was noticed by him in 1897, in his memoirs above referred to.

It is too much broken by pressure and crush to be serviceable as a figured specimen; but we may notice that it has remains of the gastric teeth.

The fossiliferous horizon in the quarry is not far below the base of the Millstone-grit at this place.

In a letter dated December 4th, 1897, Dr. W. Hind has favoured us with the following section of the strata shown in this quarry:



A. Shales with marine fauna and *Dithyrocaris*.
* Indicates the horizon at which *D. testudinea* was found.
B. Shales with *Glyphoceras spirale*.
C. Quartzose gannister-like sandstone with plant-remains.

In Dr. W. Hind's opinion these do not belong to the so-called Yoredale series, and he describes them in detail thus:

The quarry shows the following strata downwards:

A. Dark shales, with thin bands of concretionary limestone or seams of calcareous nodules, all more or less fossiliferous; with *Glyphoceras diadema*, and the fauna noted in Dr. W. Hind's Monograph, and in the 'Geol. Mag.,' 1897, pages 207, 208: 15′.

It was in the lower part of these shales that the *Dithyrocaris* (*D. testudinea*) was found, together with *Ceratiocaris Ortonensis*.

B. Thin carbonaceous shales with *Glyphoceras spirale*, *Posidoniella lævis*, *Productus cora*, and *Streptorhynchus crenistria*: 1′.

C. Hard gannister-like quartzite, with shale-partings and plant-remains: 20′. Loamy shale: 4′. Hard compact fine-grained quartzite: 4′. Dark shales a few feet to the floor.

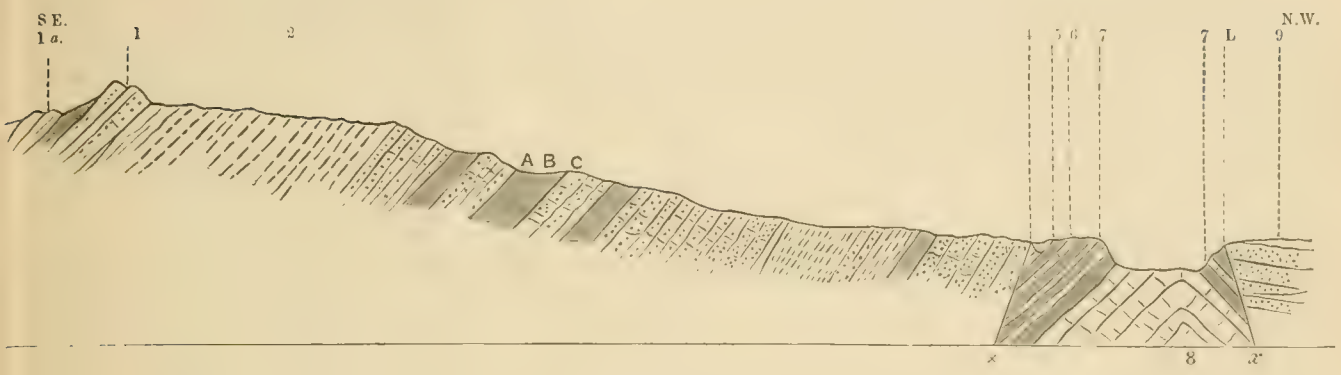
At page 72 of the 'Mem. Geol. Survey: Country round Stockport, &c.,' 1866, the strata seen in this quarry at A, B, C, are thus described:

In a quarry by the road-side, south-west of Holly Wood, we have—

Dark shale, with fossil-bearing nodules of limestones: 15′. Hard, dark-grey quartz rock (gannister), with thin partings of dark shale, containing layers of coal, from one-eighth to one-fourth of an inch thick; large Stigmaria with rootlets: 20′.

The following is a section of the Lower Carboniferous strata in Cheshire, where the roadside quarry, south-west of Holly Wood, referred to by Dr. W. Hind, is situated.

SECTION BETWEEN CONGLETON EDGE AND ASTBURY LIME-WORKS.



Excepting the beds 1 *a* at the south-east end this section is taken from p. 72, 'Memoir Geol. Survey: Country round Stockport, Macclesfield, Congleton, and Leek.'

A, B, C. The approximate position of the quarry above referred to.

1 *a*. First Grit; clay, grit, shale, and sandstone, 55′; shale, 57′; shale with a coal-seam, 102′ (see the 'Mem. Geol. Survey' here alluded to, p. 70).

1. Third Grit, 100′.
2. Shales (?), 500′.
3. Thin-bedded hard sandstones and shale, 1400′.
4. Sandstone, hard, reddish-yellow (?).
5. Dark, sandy shale, 20′.
6. Impure cannel coal, 1′.
7. Shales, with thin earthy limestones, 120′.
8. Limestone, with thin shaly partings.

× Fault. *x*. Red Rock fault. L. Limekiln Farm.

9. Lower Keuper Sandstone.

5. DITHYROCARIS SCOULERI, *M'Coy*, 1844. Plate XXI, figs. 7 *a*, *b* (?), 10 (?); Plate XXV, figs. 6 *a*—*c*, and fig. 7 (?).

DITHYROCARIS SCOULERI, *M'Coy*, 1844. Synops. Char. Carb. Foss. Ireland, p. 163, pl. xxiii, fig. 2; and 1862, ibid., edit. 2, p. 224.

— — *Morris*, 1854. Catal. Brit. Foss., edit. 2, p. 107.

— — *Griffith*, 1862. Journ. Geol. Soc. Dublin, vol. ix, p. 48.

— — *Salter and Woodward*, 1865. Chart Foss. Crust., p. 17, fig. 10.

— — *H. Woodward*, 1865. Intellect. Observer, vol. viii, pp. 323, 324, pl. o, fig. 9; 1872, Popul. Sc. Rev., vol. xi, pp. 391 and 396, pl. xc, fig. 10.

— — *Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249.

? — TESTUDINEUS [EA], *R. Etheridge, jun.*, 1879. Quart. Journ. Geol. Soc., vol. xxxv, p. 465, pl. xxiii, fig. 1.

— SCOULERI, *Nicholson*, 1879. Palæontology, edit. 2, vol. i, p. 349, fig. 204.

— — *Etheridge*, 1888. Foss. Brit., vol. i, Palæoz., p. 238.

Specific Characters.—We have not seen the original specimen of *D. Scouleri*, nor are we quite certain that we have met with any specimen truly representing that species. From the description and figure[1] published in the 'Synops. Char. Carb. Foss. Ireland' this species seems to have the following characters:—A nearly round clypeiform test (36 mm. long, 34 mm. wide), slightly convex, with a strong rugose dorsal ridge, two ocular or gastric ridges, and two rugose mesolateral ridges; otherwise smooth. A double ventral border is shown, with a marginal fringe extending from the subtriangular frontal notch to the two strong posterior spines; between these the posterior border is almost straight.

The last abdominal segment (or rather what represents its right-hand moiety), 14 mm. long, is ornamented with sinuous lines, passing obliquely backwards, from the outer edges to the centre. At the end of this segment is a broad-headed style (6 mm. wide), and a stylet on each side of it. The style, 25 mm. long in the figure, is bayonet-shaped, with oblique fine striæ on its sloping faces. The stylets (each showing a length of 22 mm.) are blade-like and tapering (about 3 mm. broad near their articulation) and coarsely striate.

The caudal spines indicate the *dorsal* aspect by their arrangement, the stylets passing under and behind the top of the style; but the piece of test at the place of the ultimate segment shows the oblique lines arranged as on the *ventral* surface. See *D. testudinea*, Pl. XXI, fig. 4.

In his 'Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland,'[2] 1844, Professor (now Sir Frederick) M'Coy refers at p. 163 to *Dithyrocaris Scouleri*, M'Coy (pl. xxiii, fig. 2), as follows:

"The characteristic length of expanded pair of valves very slightly exceeding the width; surface smooth; central and lateral ridges transversely wrinkled; frontal notch as deep as wide, rounded. Valves, when spread flat, forming a nearly orbicular shield, the length very slightly exceeding the width, and having a deep rounded notch in front; central ridge or hinge strong, rounded, regularly marked with transverse wrinkles [Pl. XXV, fig. 6 *b*]; lateral ridges marked with irregular, flat, scale-like undulations [Pl. XXV, fig. 6 *c*]; intermediate short ridges nearly straight, slightly bent towards the central ridge above and towards the lateral ridges below; surface smooth, margin of the valves narrow, fringed or obliquely striated, immediately within which, on the lateral margins, is a plain rounded ridge, divided longitudinally by a nearly mesial sulcus; it is close to and parallel with the outer margin for about the upper half of its length, then gradually turning in towards the lateral ridge, where it widens; tail exactly equalling the body in length, terminating as usual in three spines of nearly equal length, the central one triangular, marked with very fine oblique striæ, meeting at an acute angle on the central ridge; two lateral spines rounded, coarsely sulcated longitudinally. Width of the expanded pair of valves one inch four lines; length to tip of posterior spine one inch five lines; length of central spine of tail one inch."

[1] This has been photographed from M'Coy's figure, and reproduced in Pl. XXV, figs. 6 *a*—*c*.

[2] Reprinted in 1862, with Table of Fossils and Localities.

In his 'Systematic Description of the British Palæozoic Fossils in the Geological Museum of the University of Cambridge,' 1851, Fasciculus I, pp. 81, 82, after mentioning "*Dithyrocaris*, Scouler, MS.," as one of the *Apodiadæ*, M'Coy gave a generic description of it, from his knowledge evidently of *D. Colei* and *D. Scouleri*, thus:

"*Gen. Char.*—*Carapace* semi-oval, the two sides meeting along the middle at a very obtuse angle; anterior end rounded, often with an obscure notch in front; posterior end subtruncate, with the lateral angles produced backwards into short, flat, angular spines; surface faintly marked with irregular imbricating striæ, the margins being usually thickened and corrugated, and with three well-marked longitudinal ridges, one in the middle extending the entire length, and one on each side not reaching the front margin; within and anterior to the ends of these latter are two small, obliquely longitudinal, sigmoid ridges, extending inwards and forwards towards the mesial ridge; posterior part of the body naked, tail terminating in three long, strong, equal, triangular spines, the middle one bayonet-shaped with a triangular section, the lateral ones flattened. I have not yet detected any trace of eyes in this genus, which seems closely allied to *Apus*."

He then passingly alluded to *D. Scouleri*, M'Coy, but added no particulars. Our friends at Dublin and elsewhere have not been able to find the original specimen figured and described by Sir Frederick M'Coy.

In response to our inquiry respecting the original specimen, the trustees of the Griffith Collection have obligingly sent to us, as the only evidence they can find of M'Coy's *D. Scouleri* in that Collection, a plaster cast and a photograph of the slab labelled as representing that species, from Aughnaclogh. It shows only a feeble outline of what may be a *Dithyrocaris;* and we have given a representation of it in Pl. XXV, fig. 7. The outline seems to represent an imperfect suboblong carapace; one moiety is about 32 mm. long and 13 mm. wide. As far as recognisable this may have belonged to a small *D. Colei*, such as Pl. XXII, fig. 7, and Pl. XXVII, fig. 5.

By some writers on *Dithyrocaris*, *D. Scouleri*, M'Coy, has been referred to *D. testudinea* of Scouler,[1] to which the published figure bears some resemblance in general appearance. The peculiar linear ornamentation of the valves or lateral moieties, however, is altogether wanting in M'Coy's elaborate description, and in the figure which he gave of the species, reproduced here in Pl. XXV, figs. 6 *a*, *b*, *c*. The obliquely marked abdominal plate in fig. 6 *a* is doubtful in character.

Sir Richard Griffith, in the 'Journ. Geol. Soc. Dublin,' vol. ix, 1862, p. 48, refers *D. Scouleri* to the Carboniferous Slate, or Lower Limestone Shale, of the Yellow Sandstone Group (at page 100—the Arenaceous Shale of that group), at Aughnaclogh, Clogher, co. Tyrone.

[1] See p. 485, foot-note, 'Geol. Mag.,' vol. x, 1873; and dec. 2, vol. i, 1874, p. 109.

Pl. XXI, figs. 7 *a*, *b*. Mus. Geol. Surv. Scotl., *m* 4273^{b}, No. 16, and *m* 4274^{b}, F $\frac{xx}{2}$ (bis), (counterparts).

Dithyrocaris testudineus, *R. Etheridge, jun.*, 1879. Quart. Journ. Geol. Soc., vol. xxxv, p. 465, pl. xxiii, fig. 1.

Size.—Length of the valve in fig. 7 *b*, imperfect, 30 mm.; breadth of the valve about 15 mm.

Characters.—Two counterparts; an embedded left valve (fig. 7 *a*), and its cast (fig. 7 *b*). Both ends of the valve are imperfect. The mesolateral ridge is rugose, and stands up sharp on fig. 7 *a*; its hollow mould is seen in fig. 7 *b*.

The fringed edge of the ventral margin extends as far as the fracture, narrowing forwards; as it is impressed on both of the counterparts, it must have stood out free. The smooth ribbon-like band within the ventral margin is slightly convex in fig. 7 *b*, and slightly hollow in fig. 7 *a*.

These two casts of one moiety of a carapace were regarded by Mr. R. Etheridge, jun., as representing two separate valves. It was from its general shape probably that Mr. Etheridge referred this specimen to *Dithyrocaris testudinea;* but there are no remains of the peculiar ornaments of that species. Possibly it may belong to *D. Scouleri*, M'Coy, which also had smooth valves (or moieties); and in shape the hind part of the valve agrees sufficiently well.

This left half of a carapace is embedded in a split piece of brown, semi-bituminous, calcareous shale, which is micaceous, and largely composed of small, obscure, compressed Ostracoda.[1] It is from the Cement-stone group of the Calciferous Sandstone series, in the Tweeden Burn, near its junction with the Liddel Water, by New Castleton, Roxburghshire. *Posidonomyæ* occur also in this specimen of shale.

6. Dithyrocaris funiculata, sp. nov. Plate XXII, figs. 6 *a*—*d*. Mus. Geol. Surv. Scotland, F $\frac{xx}{7}$, No. 21.

Size.—The fragment of a black filmy right valve 45 mm. long, probably 50 mm. or more when it was perfect. From the ventral margin to the mesolateral ridge 15 mm.; the whole valve was probably 30 mm. wide.

Specific Characters.—One of two displaced valves. A rather narrow moiety with rather straight ventral edge. Anterior portion lost; the ventral margin strongly marked with close-set oblique striæ, not forming a fringe, but a cord-like pattern throughout (figs. 6 *a* and *c*); its posterior angle (fig. 6 *b*) shows a sub-

[1] Just as some of the oil-shales are constituted.

reticular surface, having lines parallel with the lower edge, and feeble transverse striæ. A straight mesolateral rugose ridge is present, ending at the notch above the postero-ventral spine; the filmy surface of the valve bears a faint reticulation (fig. 6 *d*), and there are some irregular accidental superficial inequalities.

The funiculate pattern of the ventral margin is peculiar, though essentially of the same nature as the more usual fringe. This form is apparently distinct from the other specimens, and we may name it *D. funiculata*. The narrow rigid shape of the valve also distinguishes it from *D. Colei* (compare fig. 7 on the same plate). On the same piece of thin black calcareous shale there is a filmy and imperfect carapace of the same species. From the Calciferous Sandstone Group; Tweeden Burn, 250 yards above its mouth, New Castleton, Roxburghshire. There is a fragment of the same species, from Tyrone, in the Brit. Mus., I 280.

7. DITHYROCARIS INSIGNIS, sp. nov. Plate XXV, figs. 3 *a*—*c*, 4, 5 *a*, *b*; Plate XXVII, figs. 1 *a*, *b*, *c*; Plate XXX, figs. 1—3; Plate XXXI, figs. 6, 7; and var. MULTIJUGATA, figs. 8 *a*, *b*, *c*, 9.

Specific Characters.—Carapace relatively large, suborbicular or suboval; with broad ventral margin ending in a long sharp spine on each side; strong mesolateral, and weaker dorsal ridge. Posterior border straight between the two postero-ventral spines, but projecting in the middle with the dorsal spine. The surface has linear and reticulate ornament.

Pl. XXV, figs. 3, 4, and 5. Leeds Mus. Coll., Nos. 33 A and 44 A.

Size.—From the mesolateral ridge to the ventral border 16 mm.

Characters.—Crushed and much displaced fragments of one or more large suborbicular carapaces on one slab. The mesolateral ridge and the fringed ventral border are well marked, and are like those in *D. tricornis*, &c. There is a faint and rather curved elevation lying obliquely in the middle of the valve, probably due to the test accidentally overlying some narrow fragment. The postero-ventral border and its spine have been much damaged. The dorsal ridge has been broken away in this specimen.

The reticulation on one part of the surface (fig. 3 *b*) consists of delicate raised, oblique, and sinuous striæ, interrupted and inosculating to form an irregular network; but on the right-hand side of the mesolateral ridge the main striæ are parallel with that ridge, and the network is therefore straighter. Figs. 4 *a*—*e* show the features of the mesolateral ridge, the rugæ passing down into the general reticulation of the surface. When highly magnified, the meshes

are seen to be punctate. Figs. 5 *a*, *b*, indicate the passage of the striæ of the upper (forward) part of the ventral fringe into the meshwork of the superficial ornament.

The history and geological position of the specimens in Pl. XXV (which were kindly sent to us by Mr. P. F. Kendall, F.G.S., of the Yorkshire College, Leeds), and of others shown in Pls. XXX and XXXI, which were obligingly communicated by Mr. E. J. Garwood, F.G.S., are recorded by Mr. Garwood in the 'Geol. Mag.,' dec. 4, vol. iv (1897), p. 556, as follows :

"At present a collector is engaged upon the fauna of the Millstone-grit at Eccup, five miles north of Leeds, where a fossiliferous black shale has been met with during the excavation of a puddle-trench for a reservoir. The bed occurs about the centre of the 'Middle Grits' of the Yorkshire Millstone-grit. The bed, which was discovered by Mr. Percy Kendall some three years ago, contains a rich marine fauna, which has not yet, however, been properly worked out. The fauna includes species of *Nucula* and *Leda* in great abundance and in excellent preservation, also numerous individual specimens of *Lingula* and *Discina*. Gasteropods occur, and a few specimens of *Goniatites*, together with well-preserved specimens of *Conularia*.

"Several specimens of *Dithyrocaris* have been found, and a single specimen of a minute Trilobite, cf. *Brachymetopus Ouralicus*. Fish-remains referable to two genera have been identified.

"The fauna appears to bear little resemblance to that of the Cayton-Gill beds of Nidderdale, which lie at approximately the same horizon in the Millstone-grit. On the whole the fauna appears to resemble in many points that of the Ridsdale Ironstone Shale of the Bernician beds of South Northumberland."

Pl. XXVII, figs. 1 *a*, *b*, *c*. Neilson Coll., B.

Size.—Fragment of a right-hand moiety, measuring 20 mm. by 20 mm. From the ventral border to the mesolateral ridge, 12 mm.

Characters.—This is a part of the postero-ventral region of the right moiety of a carapace, retaining a portion of the mesolateral ridge, with its angular rugæ; also some of the thick ventral border, with its broad margin; this passes into a narrow and almost cord-like edge in the upper (forward) part of the border (not shown in the figure).

The carapace is delicately ornamented with numerous oblique, thin, sinuous, interrupted rugulæ or wrinkles, parallel and anastomosing, having irregular interspaces (figs. 1 *b*, *c*). It is possible that in some other parts of the test these wrinkly striæ may have become more definitely reticulate; and may have approached the pattern shown by Pl. XXV, fig. 3 *b*.

In some respects this specimen approaches *D. Scouleri*, M'Coy (Pl. XXV, fig. 6); but its proportions and its ornament distinguish it.

Brownish non-calcareous shale, East Kilbride.

Leeds Mus. Coll., No. 36. Not figured.

Fragment of a large valve of *D. insignis*, measuring 20 mm. from the ventral

edge to the mesolateral ridge; the latter is strong, and the former has a simple fringe as in other species (for instance, fig. 3 *a*, Pl. XXVIII). The ornament of the surface consists of simple oblique striæ, parallel, but interrupted, with punctate interspaces, and probably passed into meshwork on other parts of the test. The specimens from Eccup occur in a hard, dark-blue, non-calcareous shale, with Posidonomya, Aviculopecten, Goniatites, &c.

Leeds Mus. Coll., No. 39 B.

This is a small right valve of *D. insignis*, 43 mm. long and 20 mm. wide; from the dorsal to the mesolateral 10 mm., and the same from that to the ventral. A neat ogee curve in its front edge resembles that in fig. 3 *a*, Pl. XVIII; and figs. 1 and 2, Pl. XXIV, have a similar feature.

The superficial ornament is a freely irregular reticulation coming off from the oblique lines crossing the ridges.

Pl. XXX, figs. 1 and 2 *a*, *b*. Leeds Mus. Coll., No. 33 A.

Characters and Size.—Two valves displaced; the right valve, turned over, has left the impression of its outside (fig. 1); the outside of the other is exposed (fig. 2 *a*).

Fig. 1, the impression of the outside of an imperfect right valve, 73 mm. long and 35 mm. wide. It shows a thick ventral rim and a strong mesolateral ridge. The posterior border, with its spines, ventral and dorsal, is well indicated, but the spines have been damaged.

Fig. 2 *a* is the outside of a left valve, 71 mm. long and 37 mm. wide. The mesolateral ridge is prominent and rugose as usual; the dorsal ridge is feebly crested. The gastric and nuchal ridges are in their places. The ventral border is broad and thick, and does not show any fringe.

Pl. XXX, figs. 3 *a*, *b*, *c*, *d*, *e*. Leeds Mus. Coll., No. 44A and 44B (counterparts).

Size.—Length of carapace, with the spines (10 mm.), 60 mm.; width 50 mm.

Character.—A nearly perfect suborbicular carapace, somewhat damaged anteriorly. Ventral border broad; much obscured by being inturned and broken. A little portion of the usual fringe is traceable on the counterpart (not figured); the different patterns of the inside and outside free edge of the ventral margin can be seen both in it and in fig. 3 *a*. The postero-ventral spines are long and sharp. Mesolateral ridges rugose and strong, especially shown by deep furrows on the counterpart, in which a gastric tooth projects at the front end of the right-hand mesolateral. The dorsal ridge is relatively weak, but ends behind in a distinct triangular spine (4 mm. long).

The ornament of the surface near the mesolateral consists of sinuous, parallel,

wrinkly striæ (like those in fig. 1 *b*, Pl. XXVII), with obscure, minute interstitial network; passing into a definite but irregular reticulation with punctate meshes (figs. 3 *b*—*e*); see the postero-ventral angle of the test, where the head of the right-hand border-spine has been slightly shifted away from its place.

Pl. XXXI, fig. 6. Leeds Mus. Coll., No. 44 B. (A trifid.)

Size.—Style 15 mm. long; 4 mm. broad at top. Left-hand stylet about 30 mm. long; 5 mm. broad at top.

Character.—This trifid shows its ventral aspect. The style is shorter than the stylets. The latter appear to have had smooth and strongly grooved surfaces. The style seems to be smooth, with a deep central sulcus, and is probably triangular in section.

This tail-piece lies close to the front end of the carapace, fig. 3 *a*, and may have belonged to that individual.

A similar trifid, specifically the same, most likely, but imperfect, is embedded in specimen No 95 A.

Plate XXXI, figs. 7 *a*, *b*. Leeds Mus. Coll., No. 602. (A caudal plate.)

Size.—Length 13 mm.; width at top 9 mm.; width at bottom 4 mm.

Characters.—This small tongue-shaped plate, tapering downwards to a rounded end, was probably part of the ultimate abdominal segment. It may have been a separate plate coating the outside of the head of the style. The ornament of chevron-lines with the angles downwards is that of the *ventral* aspect of the abdominal segments (see Pl. XXIX, figs. 10 *b*, 11 *a*, 12 *b*, and 13 *b*). The interstices are irregularly and sparsely punctate. The edges of this little plate being somewhat damaged all round.

7*. DITHYROCARIS INSIGNIS, sp. nov. Var. MULTIJUGATA, nov. Plate XXXI, figs. 8 *a*, *b*, *c*, and 9.

Characters.—Besides a strong mesolateral ridge on each valve, and the usual dorsal ridge, these specimens have another rugose ridge between the mesolateral and dorsal ridges. This ridge is not strange to *Dithyrocaris*, for it is feebly represented in the very distinct species *D. tricornis*, Pl. XXIV, fig. 1; and is traceable in *D. Colei*, fig. 2. It is a feature also in *Chænocaris tenuistriata*, Pl. XXI, figs. 8, 9, and 11, stronger than in the foregoing.

The presence of this *juxtadorsal* ridge on each side characterises some of the specimens from Eccup as a variety of *D. insignis* in that locality, inasmuch as the carapace has five instead of three prominent ridges; and we have named it

accordingly. It is smaller than the type-form, and its carapace must have been rather oval, like figs. 1 and 2, Pl. XXX, and not so orbicular as fig. 3.

Figs. 8 *a*, *b*, *c*. Leeds Mus. Coll., No. 43.

An imperfect posterior half of a left valve (about 14 mm. wide), showing the wide ventral border (as in Pl. XXX, fig. 3), with the mesolateral, juxtadorsal, and dorsal ridges very distinct. The juxtadorsal is oblique (as also in fig. 9). The left-hand edge of the dorsal ridge seems to have been squeezed in under the neighbouring part of the test. The postero-ventral spine is long and sharp; the medio-dorsal spine is much shorter.

The ornament of lines and network in fig. 8 *b* extends over the dorsal ridge and the test in its vicinity; the pattern of linear chevrons pointing downwards (backwards) passes sideways into the general reticulation. The parallel sinuous lines on one side of the limit of the dorsal ridge differ, but not essentially, from those on the left-hand side of that limit. The irregular meshes are punctate (fig. 8 *c*).

Pl. XXXI, fig. 9. Leeds Mus. Coll., No. 40.

Size.—Valve, length about 35 mm. probably when perfect; width 15 mm.

Characters.—Rather more than half of the left moiety of a carapace; imperfect at the front end. Besides the ventral border, partly fringed, the mesolateral, juxtadorsal, dorsal, and the right-hand juxtadorsal are distinct. The two juxtadorsals are set obliquely (see also fig. 8 *a*), and thus appear to be in their normal position and not squeezed out of place. They are parallel one to the other.

The gastric ridge on the left side, and the nuchal ridges on both valves, are all apparent.

8. DITHYROCARIS COLEI, *Portlock*, 1843. Plate XXII, fig. 7; Plate XXIII, figs. 1—4; Plate XXIV, figs. 2, 4; Plate XXV, figs. 9 *a*, *b*, *c* (*?*); Plate XXVII, fig. 5.

DITHYROCARIS COLEI, *Portlock*, 1843. Report Geol. Londonderry, &c., pp. 314, 565, 570, pl. xii.

— — *Morris*, 1843. Catal. Brit. Foss., p. 73.

— — *M'Coy*, 1844. Synops. Char. Carb. Foss. Ireland, p. 163.

— — *Bronn*, 1848. Index Palæont., vol. i, p. 135.

— — *Morris*, 1854. Catal. Brit. Foss., edit. 2, p. 107.

— — *R. Griffith*, 1862. Journ. Geol. Soc. Dublin, vol. ix, p. 48.

— — *M'Coy*, 1862. Synops. Char. Carb. Foss. Ireland, edit. 2, p. 224.

? — — *J. Young*, 1868. Trans. Geol. Soc. Glasgow, vol. i, p. 58.

? Dithyrocaris Colei, *J. Armstrong*, 1871. Trans. Geol. Soc. Glasgow, vol. iii, Appendix, p. 29; and 1876, Catal. W.-Scot. Foss., p. 45.
— — *H. Woodward*, 1877. Catal. Brit. Foss. Crust., p. 72.
— — *Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249.
— — *E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886 (1887), p. 63.
— — *Etheridge*, 1888. Foss. Brit., vol. i, Palæoz., p. 238.

Specific Characters.—A relatively large oval-oblong carapace (laid out flat in Pl. XXIV, fig. 2; halved in Pl. XXIII, fig. 1), with strong features of rugose dorsal and mesolateral ridges, weak juxtadorsals, ventral fringe (especially posteriorly), and posterior spines (two ventral and one dorsal). Delicate superficial ornament reticulate and subaculeate. Dorsal junction of the carapace-moieties surmounted by a serrated crest, with narrow side-flanges. In the separate half (Pl. XXIII, fig. 1) this cristate ridge, remaining prominent, shows its side-view.

All the specimens referred to above (excepting Pl. XXII, fig. 7) formed part of the original Irish series collected and described by General Portlock in 1843.

Pl. XXIII, fig. 1. Mus. Pract. Geol., 6262. 'Catal. M. P. G. Fossils,' 1865, p. 116.

Size.—Moiety of valve 75 mm. long, 41 mm. wide. The whole carapace was probably about 82 mm. wide.

Characters.—This is a right valve, showing (1) a broad ventral margin, dwindling away forwards, from which the fringe has been broken away; (2) the rugose mesolateral ridge; (3) the almost straight posterior edge; and (4) a posterior portion of the dorsal rugose ridge, terminating in the postero-dorsal spine. This ridge is rather too regular and too delicate in the drawing; only the rough ends of the chevrons come to the surface.

Overlapping the antero-dorsal (upper in the figure) region of this valve is the postero-ventral portion of another right valve, fig. 4 of Pl. XXIV.

In a black shale, micaceous and calcareous; being almost wholly composed of compressed small Ostracods. In a similar shale (some with less of the small Ostracods) are the specimens Pl. XXIII, figs. 2, 3, 4; Pl. XXIV, figs. 2, 4; and Pl. XXVII, fig. 5.

Pl. XXIII, figs. 2, 3, 4. (Tail-pieces.) Mus. Pract. Geol., Fig. 2, $\frac{36}{7}$, 6261; Fig. 3, $\frac{36}{7}$, 6261; Fig. 4, $\frac{36}{6}$, 6265.

Size.—Fig. 2. Length 80 mm. Exposed segments 35 mm.; penultimate 10 mm.; ultimate 25 mm. Style 37 mm. Stylets 39 mm.

Fig. 3. Exposed segments 40 mm.; ultimate 30 mm. Style 26 mm. Stylet 30 mm.

Fig. 4. Exposed segments 40 mm.; antepenultimate 6 mm.; penultimate 12 mm.; ultimate 22 mm.? Style 22 mm. Stylets broken at tips.

Owing to the crushed and imperfect state of the several parts these measurements are for the most part only approximate.

Characters.—Fig. 2 shows the same specimen as that represented by fig. 4, pl. xii, of Portlock's 'Report Geol. Londonderry,' 1843; with the remains of two abdominal segments and three well-preserved caudal appendages of probably normal characters and proportions; the dorsal aspect is exposed. The segments are imperfect and crushed, but the joint between the ultimate and the penultimate supplies a definite datum for their measurement. The ultimate segment bears chevron-lines, with their angles pointing forwards (upwards in the figure). The telson or style is rather shorter than the two cercopods or stylets, and all these are longitudinally striate; the style, having a median ridge, was bayonet-shaped.

Fig. 3 is the same specimen as that in fig. 5, pl. xii, *op. cit.* It has been widened and broken by pressure, so that it is difficult to measure its parts with exactness. It has been mixed up in the shale with a fragment of ventral margin, and perhaps other fragments obscure the ultimate segment, which seems to be broad and chevroned with finer lines than those in fig. 2. The tail-spines are also shorter; but the style is the shortest, as in the other examples. They are sulcate rather than striate, and somewhat granulated on the ridges, a condition due perhaps to fossilisation. Their relative position gives a ventral aspect.

Fig. 4. The same specimen as fig. 3 *a*, *op. cit.*, is also flattened and much widened by pressure. The oblique lines on the ultimate segment are directed backwards (downwards in the figure) and inwards towards the centre, thus in a contrary direction to those in figs. 2 and 3. This is the ventral feature in *D. testudinea.* The three spines may also be said to show their ventral aspect. They are broken at the tips, but resemble those of the other specimens, except that at the head of the stylets a few of the striæ converge at a sharp angle for a short distance—not nearly so far as this feature is continued in fig. 3 *a*, *op. cit.*

The surface of the segments bears patches of an attached kind of *Spirorbis* (fig. 3 *b*, *op. cit.*); minute, discoidal, and smooth; perhaps near *Sp. pusillus*, Martin.

Pl. XXIV, fig. 2. Mus. Pract. Geol., 6263.

Size.—Carapace flattened out and imperfect (the same as Portlock's pl. xii, fig. 1). Originally about 85 mm. long and 70 mm. wide. . . . . And Pl. XXIV, fig. 4. Mus. Pract. Geol., 6262 (bis). Cat. M. P. G., 1865, p. 116.

Size.—Moiety or valve 68 mm. long; including posterior spine 74 mm. About 35 mm. wide. The whole carapace was originally about 70 mm. wide.

Characters.—The flattened carapace (Pl. XXIV, fig. 2) is suboval, anteriorly contracted, and showing a relatively broad, shallow, central notch, where the edges of the two valves (or lateral moieties) turn slightly inwards and backwards to their junction.

In the separate subelliptical moieties the ventral edge is elliptically curved and depressed. The dorsal edge is straight, and provided with a rugose ridge (Pl. XXIV, fig. 2), which is seen in its side view (Pl. XXIII, fig. 1) to be crested, and to end behind in a broad triangular spine. The dorsal edge of each valve, when in apposition seems to have been overridden by the straight, narrow, rugose crest, which had narrow lateral flanges, and constituted the *medial* or *dorsal* ridge of the carapace. There is also on each valve a straight *mesial rugose* ridge, besides a shorter, coarser, and rather sinuous *cephalic* ridge, a weak *juxtadorsal*, and a thin, short, *nuchal* ridge. This last is more distinct in Pl. XXIV, fig. 4, than in fig. 2, where the two small nuchal ridges, usually parallel with each other and with the dorsal ridge between them, are somewhat displaced, probably by unequal pressure at that spot, as evidenced by the apparent local disturbance of the specimen.

The *mesolateral* ridges are attenuated in front, and curve towards the *cephalic* ridges in Pl. XXIV, fig. 2; but in fig. 4, and Pl. XXIII, fig. 1, they are straight as far as they go. They end posteriorly just above (in front of) the postero-ventral notch and spine, Pl. XXIII, fig. 1, and Pl. XXIV, fig. 4. This spine is relatively long, triangular, flat (?), and sharp; and is continuous with the depressed edge of the ventral margin. This, marked off by a smooth, thin ridge (the real solid rim of the valve, partially preserved in figs. 1 and 4), becomes narrower forward, and is furnished with a fringe, or strongly and obliquely striated border along the hinder two-thirds of its length, perfectly shown in Portlock's fig. 2, pl. xii. This narrow, flat, or depressed portion of the ventral margin appears to have been a free edge, and to have been longitudinally striated on its under side.

The fringed border of the left moiety is for the most part preserved as a narrow whitish rim of the test, with the striæ lying close together, adpressed and almost cord-like, with a partial film of shining black shale, which emphasises the minute granulation on each fibre of the fringe.

The posterior edge of the valve is nearly straight between the dorsal and the (larger) ventral spine (Pl. XXIII, fig. 1, and Pl. XXIV, fig. 4).

In the specimen illustrated by fig. 2, Pl. XXIV, the surface has a faint and delicate reticulation in the anterior part of each valve between the cephalic and dorsal ridges. It is much obscured elsewhere in the compressed shale, which has

coated or replaced the test. Wherever this permits the original surface to assert its presence, it is seen to be profusely spotted with minute triangular tubercles, or obsolete prickles; their angles pointing backwards.

General Portlock remarked, at page 315, *op. cit.*, with regard to the shape that, "As a further means of distinguishing the species, the position of the lateral lines may be noted, and the following dimensions taken into account:

Length of buckler of large specimen	. .	3·5 inches.
Total breadth of buckler	. . .	2·6 ,,
Breadth of single valve	. . .	1·3 ,,

The lateral line is nearer to the margin than to the axis, though with some variation; if, therefore, it be prolonged through the valve and considered a chord, the length would be 3·1 inches, and the versed sine or perpendicular from that line to the margin, ·7 inch, or less than one-fourth of the chord."

General Portlock's specimens, all belonging to the Lower Carboniferous Series, came from the Tyrone Shales at Clogher, and the Derry Shales at Ballynascreen; and Sir R. Griffith referred *D. Colei* to a Lower Carboniferous Shale in the Yellow-Sandstone group at Auchmaclogh, Clogher, co. Tyrone.

In 1863 Professor (now Sir Frederick) M'Coy described some specimens of *D. Colei* from Auchmaclogh, Clogher, Tyrone, which were in the Griffith Collection (Dublin). The Trustees of that Collection have kindly sent us two plaster casts of the original specimens. One of them bears also the impression of a trifid tail, like those in Pl. XXIII, figs. 2—4.

In his 'Synopsis Carb. Fossils Ireland,' M'Coy thus described the species at page 163 (without figures):

"*Sp. Ch.*—Longitudinally oval; anterior end narrow, having a shallow rounded sinus in front, posterior end broader; margins sigmoidally curved, forming an acute sinus towards the centre; sides terminating in acute, angular, flattened spines; the mesial [dorsal] ridge strongly crenated; lateral ridges almost as large as the mesial one, and similarly crenated; short, sigmoidal, anterior ones also similar; margins of the valves obliquely striated; surface otherwise perfectly smooth.

"This large species is very closely allied to the *Argas tricornis*, Scouler. Taking one half of the shield, or one valve, its length is about twice and a half the width. Length of single valves three inches seven lines, width one inch six lines."

Pl. XXII, fig. 7. Mus. Geol. Surv. Scotland, *m* 4271^{b}, F $\frac{xx}{6}$, No. 21.

Characters and Size.—This is a filmy black remnant of a left valve, 43 mm. long (formerly about 45 mm.) and 18 mm. wide. The fringed ventral margin and its posterior spine, the mesolateral rugose ridge, the indications of the posterior edge, and the spine terminating the dorsal margin are present.

These features are very like those of *D. Colei* (compare Pl. XXIII, fig. 1; XXIV, fig. 4), and we regard this Scotch specimen as a small representative of

the large Irish *D. Colei*, although the latter measures 80 × 45 mm. in contrast with 45 × 18 mm.

In dark grey micaceous calcareous shale, containing some obscure small Ostracods. From the Cement-stone Group, Tweeden Burn, 250 yards above its mouth, near New Castleton, Roxburghshire.

Another specimen, also from Tweeden Burn (F $\frac{w}{3}$, No. 18, Mus. Geol. Surv. Scotland), is also *D. Colei*, similar to Pl. XXII, fig. 7, but a fragment of a larger carapace crushed flat. Remaining fragments of ridge and ventral edge, each 45 mm. long. The distance between dorsal and mesolateral ridges 20 mm.

Pl. XXVII, fig. 5. Mus. Pract. Geol., 6260, Derry, Sheet 40, 13.

Size.—This is a fragmentary left-hand moiety; length 40 mm., width 18 mm.; both measurements being imperfect.

Character.—This imperfect half-carapace has the characteristics of a small *Dithyrocaris Colei*, and is almost exactly like the specimen shown in Pl. XXII, fig. 7. It is evidently one of the original specimens collected by the Geological Surveyors in Ireland, and described by General Portlock.

In both Pl. XXII, fig. 7, and Pl. XXVII, fig. 5, the posterior edge is well defined for half of its length as a narrow flat band, tapering slowly from the postero-ventral spine to the place of the dorso-medial spine.

9. Dithyrocaris orbicularis, *Portlock*, 1843. Plate XXIV, fig. 3. Mus. Pract. Geol., 6266.

Dithyrocaris orbicularis,	*Portlock*, 1843.	Report on the Geology of Londonderry, &c., p. 316 (not figured).
—	—	*Morris*, 1843. Catal. Brit. Foss., p. 73.
—	—	*Bronn*, 1848. Index Palæont., vol. i, p. 135.
—	—	*Morris*, 1854. Catal. Brit. Foss., edit. 2, p. 107.
—	—	*M'Coy*, 1863. Synops. Char. Carb. Fossils Ireland, p. 163.
—	—	*H. Woodward*, 1877. Catal. Brit. Foss. Crust., p. 63.
—	—	*Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249.
—	—	*E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886, p. 64.
—	—	*Etheridge*, 1888. Foss. Brit., vol. i, Pal., p. 238.

Size.—Length of carapace 18 mm.; width of carapace 24 mm.—approximately.

Specific Characters.—This represents the specimen which was described but not figured by General Portlock. The outline of its left moiety is almost semicircular, and the probably similar edge of the right valve may be regarded as conterminous with the right-hand broken edge of the specimen. This is in accordance with Portlock's view also. Its postero-ventral spine is still traceable in places. From this, across to the opposite angle (of left valve), is the obscure posterior edge of the carapace, with faint traces of the medio-dorsal and postero-ventral spines.

From the left edge the first ridge is 7 mm. From the first to the second ridge is 5 mm. From the second ridge to the right-hand edge of the specimen is 10 mm. Taking the first ridge for a *mesolateral*, and the second ridge for the *mid-dorsal* (and evidently so regarded by Portlock), the width of the valve is nearly 12 mm., and its length (and that of the carapace) is about 18 mm. (without the spines). The whole width of the carapace was probably about 24 mm.

The right valve is unfortunately hidden, and perhaps broken up under the matrix on that side, its hinder spine only remaining in evidence. The anterior edge, like that of the left valve, is lost. Besides the two prominent crenulated rugose ridges, there is a small (cephalic?) ridge between the front end of the left mesolateral ridge and the ventral edge, and some displaced fragments of similar but thinner ridges in the posterior region. The left valve, besides having an obscure trace of its posterior spine, is characterised by its fringed edge being continuous throughout.

General Portlock particularly points out the differences between the shape of this form and that of his *D. Colei*. "The length of the single valve ·6 inch, breadth ·4 inch. The lateral line prolonged, would form a chord nearly as long as the axis, and the versed sine would be ·25 inch, or more than one-third of the chord, a proportion very different from that of the preceding species." See above, page 167.

A somewhat similar orbicular carapace may be noticed in *Lepidurus bilobatus*, Packard, 'North American Phyllopods,' 1883, p. 318, pl. xv, fig. 3.

This interesting and rare Irish fossil was obtained by General Portlock and his colleagues on the Geological Survey, in the Lower Carboniferous Shale at Ballynascreen, on the Whitewater River, Derry. The shale is black, calcareous, containing a few small obscure Ostracods.

Sir Frederick M'Coy stated in his 'Carb. Foss. Ireland,' p. 163, that—

"I have only seen a few fragments probably of this species along with the last [*D. Colei*]; it is distinguished by its nearly circular outline, and its tuberculated lateral and mesial ridges and margin."

10. Dithyrocaris tricornis, *Scouler*, 1835. Plate XXII, fig. 4 (magnified part), figs. 5 *a*—*e*; Plate XXIV, figs. 1, 5 *a*, *b*, and 6; Plate XXV, figs. 9 *a*, *b*, *c* (?); Plate XXVII, figs. 2 *a*, *b*, *c*, 4 *a*—*e*.

Argas tricornis, *Scouler*,[1] 1835. Records of General Science (Thomson's), vol. i, p. 137, fig. 2; and p. 141.
— — *Bronn*, 1848. Index Palæont., vol. i, p. 102.
Dithyrocaris tricornis, *Bronn*, 1848. Ibid., vol. i, p. 433.
— — *Morris*, 1854. Catal. Brit. Foss., edit. 2, p. 107.
— — *Salter and Woodward*, 1865. Chart Foss. Crust., p. 17, fig. 12.
— — *J. Armstrong*, 1871. Trans. Geol. Soc. Glasgow, vol. iii, Appendix, p. 30; and Catal. W.-Scotl. Fossils, 1876, p. 45.
— — *H. Woodward and R. Etheridge, jun.*, 1873. Mem. Geol. Surv. Scotl., Expl. Sheet 23, Appendix, p. 99; Geol. Mag., vol. x, pp. 483, 486, pl. xvi, figs. 2 and 3.
— — *H. Woodward*, 1877. Catal. Brit. Foss. Crust., p. 73.
— — *Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249.
— — *R. Etheridge, jun.*, 1879. Quart. Journ. Geol. Soc., vol. xxxv, p. 466.
— — *J. Coutts*, 1884. Trans. Geol. Soc. Glasgow, vol. vii, pp. 200 and 327.
— — *E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886, p. 63.
— — *Etheridge*, 1888. Foss. Brit., vol. i, Palæoz., p. 238.
— — *J. Neilson*, 1894. Trans. Geol. Soc. Glasgow, vol. x, pt. 1, p. 71.

Specific Characters.—Subquadrate carapace, occurring in both an expanded (Pl. XXIV, figs. 1 and 5) and a folded state (Pl. XXIV, fig. 6); strongly ridged, both dorsally and laterally and in the cephalic region; weak *juxtadorsal* ridges are also present; the two ventral margins and the dorsal line all end with a strong triangular spine; and these three, coming into a line at the hinder end of the folded specimen, Pl. XXIV, fig. 6, originated the name "*tricornis*." Surface covered with a delicate reticulation, with thin irregular meshes, which thicken at frequent intervals into small, short, blunt spines.

[1] According to Portlock ('Report Geol. Londonderry,' 1843, p. 313), Dr. Scouler described this and another species (*A. testudineus ?*) at the meeting of the British Association at Glasgow in 1840. Not mentioned in the Report for that year.

Pl. XXIV, fig. 1. Mus. Geol. Surv. Scotl., B 3095 *a*, No. 12.

Size.—Length of each moiety or valve 63 mm., including their posterior spines. Breadth of the two valves 63 mm.

Characters.—A nearly perfect subquadrate carapace, consisting of two moieties or valves. Ventral border elliptically rounded; its thickened (double) margin, as shown by its strong impression, was marked on the inside with longitudinal delicate striæ. On the edge it bore a fringe of strong oblique striæ, or compressed prickles, pointing backwards, especially at the posterior curve, where they form a sharp serrated edge; and they are less strong at the anterior region.

The anterior margin had a gently curved medial hollow, where the two valves meet. Dorsal junction along a ridged line, which is obscurely indicated as having been a long, thin, separate (probably overriding) part of the test, with a narrow flat flange along each side, somewhat like the ridge-tiles on the roof of a house.

In Pl. XXIV, fig. 1, the flange on one side (spectator's left hand) of the dorsal ridge is definitely indicated by a thin line; but on the other side it is covered up by the black shale having been squeezed up over it inside the long thin rugose ridge (*juxtadorsal*) parallel with the thick *dorsal* ridge.

Besides the central ridge, there are two slight tuberculate ridges (*juxtadorsal*), parallel and near to it, one on each side; on the left reaching up to the *nuchal* ridge, but interrupted on the right side. These two *nuchal* ridges are thin and tuberculate, parallel, and close to the anterior part of the central (*dorsal*) ridge, and between it and the sinuous *cephalic* (*gastric* or *optic*) ridge on each moiety of the carapace.

On each valve there is also a strong, straight, and rugose or tuberculate (*mesolateral*) ridge, between the dorsal ridge and the ventral border, passing from near the gastric ridge to the posterior border just above the large spine at the postero-ventral angle. There may have been also a middle posterior spine, terminating the dorsal ridge, as in figs. 4 and 6, and Pl. XXIII, fig. 1. The rugosity of all the ridges is due to the sharp prominences of imbricated chevron-shaped scales, or successive angular outgrowths of the test.

The whole surface is sprinkled over with minute triangular tubercles, having the apex pointing backwards. The posterior corners of the test, and some parts of the ventral region, bear numerous round tubercles.

All the ridges consist of numerous overlapping, raised, chevron-like layers of test, pointing backwards. The surface of the specimen, Pl. XXIV, fig. 1, is partially obscured by thicker or thinner layers of black shale. On the outer division of the moiety on the left hand there is mostly a thick layer, leaving bare the postero-ventral angle and spine. On the inner division is a rather thinner layer, leaving its anterior third bare, with its delicate reticulation. The inner division of the right-hand valve carries a thick layer along the narrow area between

the dorsal and the neighbouring thin parallel ridge; and a thin layer or film on the rest of that part of the test allows the blunt little prickles to be recognisable, and leaves bare the anterior fourth part and some of the posterior surface.

On the outer division of the right valve a narrow thick layer of the black shale lies between the mesolateral ridge and the ventral border. The latter here shows the impression of a narrow rim, marked with very fine and silky, longitudinal, parallel striæ. This tapers forwards, and widens backward towards the root of the postero-ventral spine. A remnant of this striated rim is visible on the other (left-hand) side of the carapace, passing from beneath the fringed edge up to the anterior border, where the striæ of the fringe are closer together and pressed nearly parallel with the edge.

An *inturned* part of the ventral margin has been seen in a fragment to consist of a finely reticulated band (about 5 mm. broad), tapering backwards and bordered by a narrow, but thick, striated rim.

This reticulated band and its rim were once a part of the outside of the test, but turned down at an angle. As now seen from underneath, they lie compressed on the inside of the fringe and a narrow smooth band, Pl. XXVII, figs. 2 *a*—*c*.

In Pl. XXIV, fig. 1, there is also the relic of an abdominal segment, marked with deep sinuous transverse lines, due to the overlapping flakes of the test. In the 'Geol. Mag.,' vol. x, p. 485, pl. xv, fig. 3, the remains of three abdominal segments are indicated, but they have been partly broken away since 1873.

From black, non-calcareous shale above the Calderwood Cement-stone, Lower Carboniferous Limestone Group, East Kilbride. At the Kirktonholm Cement Works, East Kilbride. The counterpart of this remarkably fine specimen is in the Museum of Practical Geology, London. It bears the original mark of the Geol. Surv. Scotl., "B 3096 *a*," and the following label:—"Lower Carboniferous Limestone Group. Shales above Calder Wood Cement-stone, Kirkstone Holme Cement Works, East Kilbride, Lanarkshire. Cast of *Dithyrocaris tricornis*, Scouler." It is this specimen that exhibited a portion of the outer part of the ventral border, infolded and pressed flat. In hard black non-calcareous shale, Pl. XXVII, figs. 2 *a*, *b*, *c*.

Pl. XXIV, fig. 6. Mus. Techn. Coll. Glasgow. This is the original of Dr. Scouler's fig. 2, p. 137, 'Records,' &c., 1835.

Size.—Length of carapace (including spikes) 80 mm., breadth of carapace 36 mm., abdominal segments 28 mm. long, 12 mm. broad, longest spine 42 mm. long, middle spine 25 mm. long, lowest spine 28 mm., not quite perfect.

The two valves or moieties of an oblong carapace, folded together, and somewhat damaged by crush. They lie almost symmetrically, but by a transposition of parts usual in decayed and floating Phyllopods, the three rather obscure abdominal

segments, and a trifid caudal appendage, project from the lower part of the front of the carapace.

The test was sufficiently thin (probably by the loss of the external layer) to allow of the gastric teeth being exposed, together with some other (obscure) internal organs.

There is also a curved object standing out at the antero-dorsal region, and continued backwards into the cephalic region with a straight (somewhat solid, but apparently broken) stem. Whether it be a disconnected portion of the margin, or quite adventitious, is doubtful.

The thick and double ventral margin is brought out in relief, with its strong, flat, triangular spine.

The dorsal edge of this (the right) valve is distinct; possibly tuberculated anteriorly, and decidedly marked on its posterior third with a row of oblique striæ or close-set prickles, pointing backwards; and though similar to the fringe usually present on the ventral edge, it is the side view of a dorsal ridge or crest of sharp, chevron-like rugæ, and ends in a strong, flat, triangular spine, such as is seen in the allied species, *D. Colei*, Pl. XXIII, fig. 1, and Pl. XXIV, fig. 4, though not so strong. Another posterior spine of the carapace stands out below that of the dorsal margin (between it and the ventral spine), and makes the third "horn" of Scouler's *D. tricornis*. This latter spine is probably that of the left valve, which (as seen through the thin and compressed carapace) has been shifted, and broken along its mesolateral ridge.

This fossil has been described and figured in the 'Geological Magazine,' vol. x, pp. 483, pl. xvi, fig. 2. It was found one mile east of Paisley, Renfrewshire, in the same black, thin-bedded earthy limestone from which Dr. Scouler's *D. testudinea* (Pl. XXIV, fig. 7) was obtained. Both of these unique specimens have been lent to us for illustration and description by the Trustees of the Andersonian Museum in Glasgow.

Pl. XXII, figs. 5 *a*—*e*. Dunn Coll., C. 14, 29. Redesdale.

Size.—A fragment 50 mm. long by 27 mm. broad. The whole valve was probably more than 65 mm. long and 30 mm. broad.

Characters.—The antero-dorsal portion of the front end has been broken away, leaving a small part of the antero-ventral region, which retains an indication of the approximately real curvature of that portion of the ventral border. The straight edge of a portion of the middle of the crested dorsal border is evident (compare fig. 6, Pl. XXIV), and was probably continued forwards (upwards in the plate). A relatively long, sinuous, rugose *nuchal* ridge lies near the front end of the dorsal line, and joins on (with a curve) to the long, thin, rugose, *juxtadorsal* ridge, parallel to and inside the dorsal edge (just as in fig. 1, Pl. XXIV). A curved

cephalic ridge with its little crater-like end, and some protuberances near by, lie between the *nuchal* ridge and the remaining anterior end of the *mesolateral* rugose ridge of this right-hand valve.

The surface is minutely reticulate, and frequent trigonal outgrowths of the meshes form obscure or abortive prickles (figs. 5 *b*, *d*, *e*). The dorsal crest is very prominent (compare Pl. XXIII, fig. 1), showing both of its sides (figs. 5 *a*, *b*, *c*, *d*). Its chevron-like and imbricated rugæ rise out of its reticulate sides, one of which is shown in the fig. 5 *d*. Clearly marked off from the rest of the surface is one *flange* of the overriding crest, as in Pl. XXIV, fig. 1, and Pl. XX, figs. 1 *a*, 2 *a*, *b*, 3 *a* and *g*. In the arrangement of the ridges (cephalic and others) and in its subaculeate ornament this specimen closely resembles *D. tricornis* (Pl. XXIV, fig. 1); also in its reticulation, which is well preserved.

Two counterparts in a split calcareous nodule; from the shales of the Redesdale Ironstone of the Lower Carboniferous series, Northumberland. Collected by Mr. Dunn.

Pl. XXIV, figs. 5 *a*, *b*; Pl. XXII, fig. 4 (magnified part). Mus. Geol. Surv. Scotl., F $\frac{22}{9}$, No. 9.

Size.—Length 13 mm., breadth 10 mm., depth or thickness 4 mm.

Characters.—A small specimen referable to *D. tricornis*. It exhibits three obscurely rugose ridges (one dorsal and two mesolateral) along the surface, and two cephalic ridges in front. Some distortion from pressure has narrowed the right moiety, and made its mesial ridge oblique to its ventral border and to the dorsal ridge. The end view (fig. 5 *b*) shows a subquadrate outline, with sloping sides, which are the down-folded and inturned lateral expansions of the ventral margins outside the mesolateral ridges.

Pl. XXII, fig. 4, exhibits a magnified view of a part of the surface of fig. 5 *a*, comprising the right *cephalic* ridge and its crater-like *ocular* spot, and the front end of the right *mesolateral* ridge, formed, like the other ridges, of imbricating chevrons. The coarse (worn?) reticulation is also shown, and the irregularly scattered tubercles or false prickles.

This interesting little fossil has been referred to and figured in the 'Geol. Mag.,' vol. x, p. 485; and dec. 2, vol. i, p. 111, pl. v, fig. 7.

In black calcareous shale. From the Lower Limestone group, Kirktonholme Cement Works, East Kilbride. Mr. A. Patton Coll.

Pl. XXVII, figs. 4 *a*—*e*. Neilson Coll., F.

Size.—Length of carapace 17 mm., breadth 13 mm., depth 5 mm.

Characters.—A small individual like *D. tricornis*, of a neat suboval shape, and

retaining the carapace whole, having its dorsal and two mesolateral ridges, and other characteristic features, including a reticulate and subaculeate ornament of the surface.

Compare Pl. XXII, figs. 5 *d*, *e* (for the ornament); Pl. XXIV, figs. 5 *a*, *b* (for shape and outline).

This well-preserved specimen clearly exhibits the clypeiform test, with its dorsal convexity (fig. 4 *b*), when looked at sideways, and its suboblong and angulate shape when viewed from front or behind (figs. 4 *c*, *d*). Its dorsal ridge and ornament are magnified in fig. 4 *e*.

From Kirktonholme, East Kilbride.

Pl. XXV, figs. 9 *a*—*c*. Mus. Geol. Surv. Scotland, F $\frac{xx}{5}$, No. 20.

This is a large separate dorsal ridge, possibly belonging to *D. tricornis* or *D. Colei*, or even to a different species.

Size.—Length probably about 60 mm. when perfect; width in the middle 5 mm.

Characters.—A long, narrow, fusiform, rugose ridge, with a flat narrow flange along each side. Thus it matches such a dorsal ridge as belongs to *D. tricornis* (Pl. XXIV, figs. 1 and 6) or *D. Colei* (Pl. XXIV, fig. 2). The latter seems to have had a rather longer carapace and ridge than the former, but its ridge is not so thick.

The rugosity of fig. 9, Pl. XXV, has a slight difference of structure from that of the other rugose ridges (Pl. XX, figs. 2 *b*, 3 *g*), due to the divisions of the chevrons being more exactly alternate in their distances and in their extent over the ridge, so that there appears to be almost a double row of rounded rugæ along this ridge. This, however, may have been the character of an individual, not of a species (see *D. granulata*, Pl. XX, figs. 2 *b* and 3 *g*).

In brownish calcareous shale. From the Calciferous Sandstone group at Larriston Burn, near New Castleton, Roxburghshire.

If this dorsal ridge belonged to either *D. tricornis* or *D. Colei*, both species are also represented in the Roxburghshire beds.

Pl. XXV, figs. 10 *a*—*c*. Mus. Geol. Surv. Scotland, F $\frac{xx}{5}$, No. 20.

The surface of the piece of hard shale in which the foregoing dorsal ridge is embedded is covered with scattered carapaces of small Ostracoda, mainly if not entirely belonging to *Kirkbya plicata* (figs. 10 *a*, side view; 10 *b*, edge view; and 10 *c*, end view).

My friend Mr. J. W. Kirkby tells me that from this locality (Larriston Quarry) the Geological Surveyors of Scotland have obtained several good sets of Ostracoda, which he has determined as *Leperditia Okeni* (and varieties), *Kirkbya costata*, *K.*

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Mr. Dunn has favoured us with the following note on the succession of strata comprised in the "Redesdale Limestone and Shale." The late Mr. George Tate, of Alnwick, divided the Carboniferous rocks of Northumberland into the—

1. Coal-measures		about	2000 feet.
2. Mountain-limestone	Calcareous	,,	900 ,,
	Carbonaceous	,,	1700 ,,
3. Tuedian		,,	1000 ,,

The "Redesdale beds" belong to the base of the "Calcareous" division, and they are as follow:

1. Shale, containing "Leaf" ironstone nodules. Often replaced by red Boulder-clay, 10 feet.

2. Redesdale Limestone, 14 feet.

3. Clayey Sandstone, containing *Stigmaria* with rootlets, 16 inches.

4. Yellow, fine-grained Sandstone, calcareous in many places, 9 feet.

5. Ironstone Shale, 30 feet. Near the top is an ironstone band, about 4 inches thick, and full of organic remains. Fossiliferous ironstone nodules, sometimes in beds, are scattered throughout this shale.

6. Sandstone, 60 feet. A coal-seam,[1] 14 inches thick, occurs in this sandstone.

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11. Dithyrocaris Belli, *H. Woodward*, 1871. Plate XVIII, figs. 8 *a*, *b*, *c*.

Dithyrocaris striatus,	*H. Woodward*,	1871.	Rep. Brit. Assoc. for 1870, Sections, p. 90.
—	Belli, *H. Woodward*,	1871.	Geol. Mag., vol. viii, p. 106, pl. iii, fig. 5.
—	—	— 1872.	Canadian Naturalist, vol. vi, pp. 18, 19.
—	—	*S. A. Miller*, 1877.	Americ. Palæoz. Foss., p. 217.
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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1899.

LONDON:

MDCCCXCIX.

A MONOGRAPH

OF THE

BRITISH PALÆOZOIC PHYLLOPODA

(PHYLLOCARIDA, Packard).

BY

PROF. T. RUPERT JONES, F.R.S., F.G.S., &c.,

AND

DR. HENRY WOODWARD, F.R.S., F.G.S., &c.

PART IV.

(CONCLUSION.)

General Title-page; Pages i—xv, 175, 176 (reprinted), 177—211; Plates XXVI—XXXI.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1899.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

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PART IV.

11. Dithyrocaris Belli, *H. Woodward*, 1871. Plate XVIII, figs. 8 *a*, *b*, *c*.

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— — *Bigsby*, 1878. Thesaur. Dev.-Carb., p. 27.
— — *Packard*, 1883. Monogr. North-American Phyll. Crust., p. 452.
— — *Etheridge, Woodward, and Jones*, 1887. Rep. Brit. Assoc. for 1886, p. 65.
— — *Hall and Clarke*, 1888. Geol. Surv. New York, Palæontology, vol. vii, p. 194.
Mesothyra Belli, *S. A. Miller*, 1889. N.-American Geol. Palæont., pp. 545 and 556.
Dithyrocaris Belli, *A. W. Vogdes*, 1893. Bibliogr. Palæoz. Crust., p. 382.

Size.—Length (imperfect) 33 mm.; breadth of the two valves, shifted one on the other partially, 25 mm.; breadth of single valve probably 13 mm.

Specific Characters.—Two valves, both imperfect anteriorly. The right valve shifted forwards and partially overlapping the other at the dorsal edge; its hinder border obscure. The left valve has its posterior spine and postero-ventral region fairly exposed, with its serrated margin (fig. 8 *b*).

Each valve bears a slightly curved mesolateral ridge, marked with chevrons pointing backwards (downwards in figs. 8 *a*, *b*). The two mesolaterals are brought close together in front by the oblique shifting of the valves one on the other. The surface of the valves is ornamented with numerous delicate riblets, parallel with the mesolateral ridge and the ventral margin; some die out without reaching the posterior region. The interstices between the riblets are filled with a transverse and oblique irregular reticulation (fig. 8 *c*). An outer or second lateral ridge near the ventral margin is just visible, but rather more distinctly on the right than on the left valve.

No eye-spot is present, but a slight unevenness of the surface between the incurved ridges near the posterior end seems to have been taken for it in the

reversed figure given in the 'Geol. Mag.,' 1871, pl. iii, fig. 5. In the 'Fifth Report on Palæoz. Phyllopoda,' 1887, p. 65, it was suggested that it is possible that the figure represents two opposite valves reversed and one overlapping the other on their inner margins.

This unique specimen (British Museum, No. 25) is in grey, finely laminated sandstone (not calcareous); from the Middle Devonian, Gaspé, Province of Quebec, Canada.

Chænocaris,[1] gen. nov.

This differs from *Dithyrocaris* in not having a dorsal overriding ridge, and in its valves folding down at the sides; gaping, however, and not quite closed along the ventral region, so far as known at present.

1. Chænocaris tenuistriata (*M'Coy*, 1844).[2] Plate XXI, figs. 8, 9, 11 *a*—*f*; Plate XXIV, fig. 8; Plate XXXI, fig. 5.

Dithyrocaris tenuistriatus, *R. Griffith*, 1842. Notice respecting the Fossils of the Mountain-Limestone of Ireland,[3] p. 22 (Table). Nomen nudum ex Maccoyii manuscripto.

? Avicula paradoxides, *De Koninck*, 1842. Descript. Anim. Foss. Terrain Carbonif. Belgique, p. 139, pl. vi, fig. 6.

Dithyrocaris tenuistriatus, *M'Coy*, 1844. Synops. Char. Foss. Carb. Limest. Ireland, p. 164, pl. xxiii, fig. 3; and 1862, edit. 2, p. 234.

Avicula paradoxides, *Bronn*, 1848. Index Palæont., vol. i, p. 140.

Dithyrocaris tenuistriatus, *Morris*. Catal. Brit. Foss., edit. 2, p. 107.

— — *Salter and Woodward*, 1865. Chart Foss. Crust., p. 17, fig. 13.

— — *R. Griffith*, 1866. Journ. Geol. Soc. Dublin, vol. ix, pp. 68 and 100.

— — *H. Woodward*, 1871. Geol. Mag., vol. viii, p. 106, pl. iii, fig. 4, and p. 521; and Report Brit. Assoc. for 1871 (1872), p. 53.

? — — *J. Armstrong*, 1871. Trans. Geol. Soc. Glasgow, vol. iii, Appendix, p. 30.

? — — *J. R. S. Hunter*, 1875. Palæont. Carbonif. Strata[4] W. Scotland, part ii, p. 39.

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[1] Χαίνω, I gape; and καρίς, a shrimp.

[2] Or 1842 according to Griffith.

[3] M'Coy is referred to at p. 8 as having named this and other new species.

[4] The specimen here referred to is said to have come from the "Gannister Limestone and Shales, Upper Limestone series, Carluke."

Dithyrocaris tenuistriatus,	*H. Woodward*,	1877. Catal. Brit. Foss. Crust., p. 73.
—	—	*Bigsby*, 1878. Thesaur. Dev.-Carb., p. 249.
—	—	*Packard*, 1883. North-Amer. Phyll., p. 452.
—	—	*E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886, p. 64.
—	—	*Etheridge*, 1888. Foss. Brit., vol. i, Palæoz., p. 238.

The reference of this species to de Koninck's *Avicula (?) paradoxides*, as probably the same, was suggested in the 'Geol. Mag.,' 1871, p. 106; but since de Koninck's determination of his fossil is avowedly doubtful and provisional, and as we have not the original before us, and the figures are unsatisfactory, we cannot take it as the published "type." An important remark by Prof. L. G. de Koninck about his fossil is thus given in the 'Description des Animaux fossiles qui se trouvent dans le Terrain Carbonifère de Belgique,' par L. de Koninck, Texte, 4to, Liége, Paris, and Bonn, 1842–4, p. 139. "15. *Avicula paradoxides*, pl. vi, figs. 6 *a*, *b*, *c*. Nous sommes loin d'être certain si cette espèce appartient réellement au genre auquel nous la rapportons," and in which he placed it not knowing any other genus to which its form has any analogy. From the Upper Carboniferous Limestone of Visé, very rare.

Sir Richard Griffith used the name *D. tenuistriatus* in 1842, from M'Coy's information. Sir Frederick M'Coy's description of the species, at p. 164 of his 'Synopsis Char. Carb. Fossils of Ireland,' is as follows:

"Valves elongate, ovate, rounded anteally, obtusely pointed retrally, convex; mesial ridge large, running nearly the entire length of the valve; two smaller ridges close to and parallel with the inner margin; about one fifth of the length from the anterior end, and situate between the mesial and internal ridges, there is a short sigmoidal ridge, and a fifth one at the anterior end defines, for a short way, the line which separates the flat external margin from the convex part of the valve; surface finely and regularly striated longitudinally.

"This species differs from all others of the genus in the want of the retral spine to the valve; it is also much more convex than any of its congeners; fragments may be discriminated by the regularity and fineness of the striæ. Length of the valve one inch, width five lines."

The upper one of the two figures given as "fig. 3," in M'Coy's pl. xxiii, is here repeated in Pl. XXIV, fig. 8. The locality for this specimen is stated by Sir Richard Griffith ('Journ. Geol. Soc. Dublin,' vol. ix, p. 68) to be Little Island, Cork; and at p. 100 it is referred to the Lower Carboniferous Limestone.

Pl. XXI, fig. 8. Brit. Mus., No. 32938, No. 23.

Size.—Length of valve 40 mm.; breadth of valve 14 mm.

Characters.—This is a left valve, oblong, convex along the middle; obliquely rounded in front; partly rounded behind, but showing a postero-ventral spine (damaged), and a notch (broken, and obscured by matrix). Surface apparently

smooth, having probably lost the thin external ornamented coat. Ventral margin depressed and apparently simple (but other specimens show that it turned in at the edge). Dorsal margin quite simple and straight as far as it is preserved. Along the middle of the valve is a raised ridge (mesolateral) without visible rugæ. At its front end it curves gently towards the antero-dorsal corner of the valve, and almost touches the middle of the somewhat sigmoidal *cephalic* ridge. Near and parallel to the middle part of the dorsal margin is a thin ridge (juxta-dorsal), disappearing forward among some feeble elevations accompanying a faint *nuchal* ridge. In grey Carboniferous Limestone from Visé, Belgium.

Variety (?).—Mounted with the foregoing there is a smaller specimen of a left valve of the same species, also from Visé (in cream-coloured limestone, with a small Gasteropod and other little fossils). This presents the same features as fig. 8, but differs in size and proportions; its ventral edge is more broadly depressed, and its median convexity is proportionally greater.

Size.—Length 13 mm.; breadth 7 mm.

Pl. XXI, fig. 9. Brit. Mus., No. 44987, No. 24.

Size.—Length of valve, imperfect, about 30 mm.; breadth of valve about 12 mm.

Characters.—A left valve, similar in general features to fig. 8, but not so obliquely rounded in front; imperfect behind. The little cephalic ridge ends behind in a small smooth knob. The surface is ornamented with numerous, delicate, closely-set striæ, curving round the front part of the valve, parallel with its border, and passing along the ventral region. The thin ridge near the dorsal border dies away forwards among numerous, small, sinuous striæ, irregularly parallel, and passing away backwards into the longitudinal striæ of the dorsal region, which are not very distinct in this specimen.

A part of a smaller valve is attached to this little piece of limestone.

This specimen (fig. 9) has been described and figured in the 'Geol. Mag.,' vol. viii, 1871, p. 106, pl. iii, fig. 4. It is from the Carboniferous Limestone of Settle, West Yorkshire. Collected by the late Mr. J. H. Burrow.

Pl. XXI, figs. 11 *a*—*f*. Mus. Univ. Cambridge.

Size.—Length of valve, imperfect, 35 mm., probably 39 mm. when perfect; breadth of valve 15 mm.

Characters.—This is a right valve, presenting the characteristic features of fig. 8, but slightly broader, and with more distinct ornament of the surface. Near the ventral margin the striæ are simple, though divergent (fig. 11 *d*); along the mesolateral ridge they run up on both sides and coincide with the angular lines of obscure chevrons (fig. 11 *e*; better seen in another specimen, not figured),

which essentially constitute angular rugæ pointing backwards, as in *Dithyrocaris*. At places on the surface one set of striæ cross another set, making a definite reticulation (fig. 11 *e*) near the mesolateral ridge; see also fig. 8 *a*, Pl. XVIII; elsewhere, in the front part of the valve, one set retain and the other lose their continuity (fig. 11 *f*). In this latter case the striæ form continuous parallel lines, with interspaces partially and irregularly traversed by short oblique lines (fig. 11 *f*). Compare Pl. XVIII, figs. 8 *b* and 8 *c*; also compare F. A. Römer's *D.* (*?*) *Jaschei*, 1855 (Pl. XXIX, fig. 15 *c*).

The specimen under notice exhibits the inturned edge of the ventral margin very clearly, as shown in figs. 11 *b* and 11 *c*; it has a strong rim along the angle of its bend, and another (slighter) along its lower or inner edge.

From the Carboniferous Limestone of Settle, Yorkshire. J. H. Burrow Coll.

Pl. XXXI, fig. 5. Mus. Univ. Cambridge.

A small and imperfect left valve, here enlarged $3\frac{1}{2}$ diameters, to show its ornament of delicate, regular, parallel, longitudinal striæ, reaching up to the anterior region, and curving inwards to the middle ridge, and parallel to the edge of the valve in the postero-ventral region.

From Settle (Burrow Coll.).

2. Chænocaris Youngii, sp. nov. Plate XXII, figs. 1 *a*—*e*. Dr. John Young's Coll. (Robroyston).

Size.—Length 6 mm.; width 3 mm.; thickness of carapace, with the valves partially closed (figs. 1 *c* and *d*), 2·4 mm.

In its general aspect this little specimen closely resembles *Ch. tenuistriata*, Pl. XXI, figs. 8, 9, and 11. The relative position of the two moieties of the carapace (Pl. XXII, fig. 1 *d*) may indicate the natural stable condition in the life of the animal, or may be due to the imperfect closing of the valves of this species, filled in with the matrix of black shale. In its small size this specimen differs from those described in the preceding pages: its cephalic ridge is not so sigmoidal, and, owing to a curved sulcus behind it, seems to be raised on a cushion-like elevation; its surface is not at all striate, but punctulate, especially near the mesolateral ridge, which is a prominent feature in this, as in the other specimens. This ridge has minute lateral notches, formed by the interspaces of the pitting being exaggerated into little buttresses of the ridge (fig. 1 *e*); and these are very analogous to the junctions of the oblique striæ with the ridge in Pl. XXI, fig. 11 *e*, and not quite so closely to those in Pl. XXII, fig. 4.

Owing to the distinctive features described above, we regard this as a new

species, named after Dr. John Young, F.G.S., Under-keeper of the Hunterian Museum, University, Glasgow, who possesses the specimen.

From Lower Carboniferous series. In the Upper Limestone group, at Robroyston,[1] Lanarkshire; with black, non-calcareous shale, about 300 fathoms below the Ell Coal.

At Robroyston, about three miles north-east of Glasgow; the strata are under the Upper Limestone, in the Possil Ironstone series.

Calyptocaris,[2] gen. nov.

This phyllopod differs from *Dithyrocaris* in having had a bivalved shell capable of being closed. Its costulate ornament approximates to that of *D. Belli*.

1. Calyptocaris striata (*H. Woodward*), 1871. Plate XVIII, fig. 7.

	Dithyrocaris striatus,	*H. Woodward*,	1871.	Report Brit. Assoc. for 1870, Sections, p. 91.
?	— striata,	*Woodward and Etheridge*,	1873.	Memoir Geol. Surv. Scotland, Explan. Sheet 23, Appendix, pp. 49, 57, 100; Geol. Mag., 1874, p. 109, pl. v, fig. 6; Report Brit. Assoc. for 1873, Sections, p. 92.
—	—	*Armstrong and others*,	1876.	Catal. W.-Scotl. Fossils, p. 29.
—	—	*Bigsby*,	1878.	Thesaur. Dev.-Carb., p. 249.
—	—	*E., W., and J.*,	1887.	Rep. Brit. Assoc. for 1886, p. 65.
—	—	*W. W. and J.*,	1899.	Geol. Mag., dec. 4, vol. vi, p. 28.
—	—	—	1899.	Rep. Brit. Assoc. for 1898, p. 520.
	Calyptocaris striata,	—	1899.	Geol. Mag., dec. 4, vol. vi, p. 29.
—	—	—	1899.	Rep. Brit. Assoc. for 1898, p. 521.

Size.—Length of valve probably 30 mm.; breadth of valve is 15 mm.

Specific Characters.—This imperfect bivalved test has been filled with matrix, and the hinder moiety has been broken away. The remaining front part represents the exterior of the left valve; the hinder moiety shows the inside of the right valve as far as it reaches; the posterior border of both valves is absent. The front end of the left valve is obliquely truncate, with rounded corners; and it formed apparently one side of an open angle between the antero-dorsal regions of the two valves when they were perfect and open. The surface bears eight or nine longitudinal riblets; those on the ventral region are parallel to the curved

[1] A description of this locality is given at p. 88 of the 'Catalogue Western-Scottish Fossils,' 1876. *D. tenuistriata*, at pp. 45 and 89, probably refers to this fossil specimen.

[2] Καλύπτω, I close or hide; and καρίς, a shrimp.

margin; those on the middle and dorsal regions are straight. No gastric nor optic ridges are visible.

The transverse fracture shows the thinness of the compressed fossil (scarcely one millimetre).

The former reference of this little fossil to *Dithyrocaris* is probably incorrect, as intimated in the 'Geol. Mag.,' 1874, p. 109, although its longitudinal riblets are not without analogies in *D. Belli* (Pl. XVIII, fig. 8, and 'Geol. Mag.,' 1871, p. 106, pl. iii, fig. 5). Nor does it fall in with the *Ceratiocaridæ*, although it has some likeness to *Ceratiocaris Salteriana*, J. & W., 'Monograph,' 1888, p. 55, Pl. VII, figs. 1, 2, 3. The ornament of several parallel, slightly curved ridges along the lateral moieties of the test are seen in Packard's figure of *Lepidurus Colleii*, 'North American Phyll.,' pl. xv, fig. 2.

Tropidocaris and *Rhinocaris*[1] (other Phyllocarids related to *Ceratiocaris*) have carapace-valves bearing longitudinal riblets, but much coarser than those of either *C. striata* or *D. Belli*, and the valves themselves differ in shape considerably from those of the two latter forms. Compare also *Ptychocaris*, Novák, 'Sitz. Böhm. Ges. Wissensch.,' 1885, p. 345, pl. o, figs. 4—8, with its numerous striæ and pitted interspaces.

This unique speciimen (Mus. Geol. Surv. Scot. *m* 576 A, F $\frac{12}{96}$, No. 15) was collected from a "greenish-grey" (now reddish), flaggy, calcareous shale of the Lower Red Sandstone, of the Calciferous Sandstone series at the Carmichael Burn, near the Manse, four and a half miles south-east of Lanark.

We have to notice that a granular band, 1 mm. wide, is associated with the border of the valves, looking as if some soft material had been squeezed out from between the valves, and had helped to form a concretionary border there. It is included in the left-hand margin in the figure of the carapace.

2. Calyptocaris? Richteriana, sp. nov. Plate XXII, fig. 2.

Size.—Length 6 mm.; width 3·2 mm. Imperfect.

Characters.—This figure is copied from a sketch made by our friend Mr. J. W. Kirkby, who recognised it (in 1864) in some hard red shale of the so-called "Cypridinen-Schiefer" (Entomis-shales), sent by the late Dr. R. Richter from Saalfeld, Sachsen-Meiningen.

The surface is coarsely striate, and has three longitudinal riblets; unfortunately the outline is imperfect, and there are no characteristic cephalic eminences. It may indeed have some relationship with *Chænocaris* as well as with *Calyptocaris*.

It is here introduced as indicative of the wide range of the costulate forms.

[1] Hall and Clarke, 'Palæont. New York,' vol. vii (1888), pp. 184, 195, pls. xxx and xxxi.

Though not a perfect valve, yet it has distinct characters of its own, sufficient to induce us to give it a name, so that it may be noted and catalogued by our friends in Germany. It is named after the above-named worthy geologist, who for many years worked at the history of the Entomostracous Crustacea and other fossils of the Devonian and Permian strata.

Caudal Extremities of Dithyrocaris, *&c., some of them Foreign.*

Several have been already described as belonging to known species in the preceding pages, as indicated by the following Table.

(For the proportional characters of style and stylets see the Table at p. 134.)

PLATE	FIG.	SPECIES.	PAGE
XIX.	3	*D. glabra*	138
—	4	—	139
XXI.	4	*D. testudinea*	149
—	5	—	150
—	10	—	187
XXIII.	2	*D. Colei*	165
—	3		
—	4		
—	5	*D. lateralis*	185
—	6	—	184
—	7	*D. testudinea*	150
—	8	—	151
—	9	*D. Dunnii*	186
—	10		
—	11	*D. glabra*	140
XXIV.	1	*D. tricornis*	172
—	6		
—	7	*D. testudinea*	146
XXV.	6	*D. Scouleri*	156
XXIX.	1	*D. Dunnii*	186
—	2		
—	3*a*	*D. Neilsoni*	187
XXIX.	3*b*	*D. Neilsoni*	187
—	3*c*		
—	4	*Rh. venosa*	188
—	5	*D. carbonaria*	190
—	6		
—	7	*D. Kochi*	191
—	8		
—	9	*D. breviaculeata*	191
—	10	*D. testudinea*	153
—	11		
—	12		
—	13		
—	14		
—	15	*Pt. ? Jaschei*	193
—	16		
XXXI.	4	*D. testudinea*	150
—	6	*D. insignis*	162
—	7		
		Sp. *D.* ?	188
		D. Kayseri	192
		M. Neptuni	192
		M. oceani	193

12. Dithyrocaris lateralis, *M'Coy*, 1851. Plate XXIII, figs. 5 and 6.

Specific Characters. — This is a well-marked three-spined tail-piece; first described by M'Coy, in 1851, as a specimen from Derbyshire, and now also recognised from Roxburghshire. Its relationship to the known species of *Dithyrocaris* is not clear; but it may have belonged to a large form of *D. testudinea* (compare Pl. XXI, fig. 5), or a small form of *D. tricornis* (see Pl. XXIV, fig. 6).

Pl. XXIII, fig. 6. Mus. Univ. Cambridge.

Dithyrocaris	lateralis,	*M'Coy*, 1851.	Brit. Pal. Foss. Cambridge Mus., fasc. 1, p. 182, pl. 3 I, fig. 36.
—	—	*Morris*, 1854.	Catal. Brit. Foss., edit. 2, p. 107.
—	—	*E., W., and J.*, 1887.	Rep. Brit. Assoc. for 1886, p. 64.
—	—	*Etheridge*, 1888.	Brit. Foss., vol. i, Palæoz., p. 238.

Size and Characters.—A trifid caudal appendage, showing the dorsal aspect; both the telson (style) and the cercopods (stylets) are imperfect at their proximal ends; but they measure, approximately—the style, 25 mm.; the stylets, 36 mm. in length. The former is bayonet-shaped, with a mid-rib; the latter, coarsely striate or sulcate, with four costulæ, are longer than the style. This trifid may possibly belong to *Dithyrocaris testudinea* or a closely allied form. The figure referred to above as given in the 'Brit. Pal. Foss. Cambridge' is partly a restoration, not quite matching the specimen in the University Museum.

"From the black beds over the Main Limestone of Derbyshire." W. Hopkins Coll.

The following remarks on this specimen (fig. 6) are given in M'Coy's 'Pal. Foss. Cambridge Mus.,' fasc. i, 1851, p. 182:

"I have examined four species [of *Dithyrocaris*] from the Carboniferous rocks of Ireland, but the only British example I have seen is a specimen in the collection [Cambridge] from the black Carboniferous Limestone of Derbyshire, indistinctly preserved, but most probably the tripartite tail of a new species, allied to *D. Colei* (Portl.), 'Geol. Rep.,' pl. xii, and to the *D. Scouleri* (M'Coy) figured in my 'Synopsis of the Carb. Foss. of Ireland,' pl. xxiii, fig. 2, from the black shales of Aughnaclough, Clogher.

"In this species the central angularly ridged spine is about ten lines long; the two lateral spines about one inch five lines long, coarsely sulcated longitudinally with only three or four strong ridges; this great excess of the lateral over the medial spine seems to characterise the species very well, and I would provisionally call it *Dithyrocaris lateralis* (M'Coy); when imperfect, the coarseness of the few large sulci of the lateral spines easily distinguishes those parts from the two figured species alluded to."

Pl. XXIII, fig. 5. Mus. Geol. Surv. Scotl., *m* 4267^{b}, No. 25, F $\frac{xx}{10}$; and *m* 4268^{b} (counterparts).

Size and Characters.—This trifid tail-piece closely corresponds with M'Coy's *D. lateralis;* but shows the ventral aspect. The style is bayonet-shaped, measuring 31 mm. in length; the stylets are 42 mm. long, striate; all have adventitious granulations. Their proximal ends are more perfect than in the Cambridge specimen of *D. lateralis.*

From Tweeden Burn, 250 yards above its mouth, near New Castleton, Roxburghshire.

This specimen is embedded in a hard black shale of the Cement-stone, micaceous and calcareous, containing obscure small Ostracods. It is associated with three other pieces of the same shale, including its counterpart; *m* 4269 ^{b} shows another, but imperfect trifid; *m* 4270 ^{b} contains the fragment of a small dorsal rugose ridge. This is 15 mm. long, and represents probably two-thirds of the original, and is evidently the relic of some small or immature carapace, only about 20 mm. in length.

13. Dithyrocaris Dunnii, sp. nov., *J. and W.* Plate XXIII, figs. 9 and 10; Pl. XXIX, figs. 1 and 2.

Pl. XXIII, figs. 9 and 10. Dunn Coll., $\frac{2\,8}{1}$ and $\frac{2\,8}{b}$. (Redesdale.)

Size.—Fig. 9 ($\frac{2\,8}{1}$) { Style 10 mm. long; 6 mm. broad at top (head or caudal plate). Ventral ? aspect. Stylets broken (fragments 11 mm. long).

,, Fig. 10 ($\frac{2\,8}{b}$) { Style 10 mm. long; 5 mm. broad at top (head or caudal plate). Dorsal aspect. Stylets broken (fragments 8 mm. long).

Specific Characters.—The two specimens (figs. 9 and 10) serve as the type of the species. They were collected by Mr. John Dunn, of Redesdale, from the "deaf" nodules in the Redesdale shales.[1] A part of the last abdominal segment, much crushed, is retained in each specimen, smooth, with a broad, flat, trifid tail attached. They are peculiar on account of the broadly triangular style and the narrow stylets, originally rather longer than the style, and obscurely sulcate.

Pl. XXIX, fig. 1. Mus. Geol. Surv. Scotl., F $\frac{xx}{2}$, No. 16. (Larriston Burn.)

,, fig. 2. Mus. Geol. Surv. Scotl., F $\frac{xx}{4}$, No. 19. (Harelow Hill Quarry.)

Size.—Fig. 1 { Style imperfect, 20 mm. long; 7 mm. wide at the top. Stylet (the most perfect) 30 mm. long.

,, Fig. 2 { Style imperfect, 30 mm. long (not much longer originally); 10 mm. wide at the top. Stylets broken.

Characters.—These two imperfect specimens, though much larger, seem to be closely related to *D. Dunnii* (Pl. XXIII, figs. 8 and 9), by the relatively short and

[1] See page 176. The ironstone nodules in the uppermost bed of shale are called "deaf" when they have become oxidised.

broadly triangular styles. Better specimens, however, are desirable for definite determination.

Fig. 1, from the dark-coloured calcareous shale of the Calciferous Sandstone group at Larriston Burn, six miles north of New Castleton, has the head of the style crushed, but obscurely striate as if masked with the dorsal face of an ultimate segment, broken and displaced. The stylets are coarsely striated, one of them long and curved, has 8 or 9 costulæ; the other has left only an impression of part of its proximal end. Together with it is a portion of a strong oblique rugose ridge.

Fig. 2, from the dark-coloured calcareous (?) shale of the Calciferous Sandstone group at Harelow Hill Quarry, Penton, Cannobie, has the head of the style pyriform, longitudinally striate, narrowing and sulcate below. There is an obscure fragment of one stylet.

14. Dithyrocaris Neilsoni, sp. nov., *J. and W.* Plate XXIX, figs. 3 *a*, 3 *b*, 3 *c*. Neilson Coll., K.

Size.—Fig. 3 *a* { Style 22 mm. long (including the head).
Stylet 23 mm. long.

,, Fig. 3 *b*—Stylet 26 mm. long.

,, Fig. 3 *c* { Style (broken) 18 mm. long; 3 mm. wide near the top.
Stylet 15 mm. long.

Specific Characters:

Fig. 3 *a*.—These are three slender caudal spines of nearly equal length, all sulcated. Dorsal aspect. The style has a mid-ridge. The others are not quite perfect at the top.

Fig. 3 *b*.—There is one stylet, slender, not quite perfect, slightly curved, and sulcate; the other is lost. The style is bayonet-shaped.

Fig. 3 *c*.—Caudal spines apparently sulcate; dorsal aspect.

All in black shale, some with adventitious granules. Small Molluscan shells lie in the shale.

Compare these with the trifid shown in Pl. XXIII, fig. 7, which is of still smaller size, but has the style longer than the stylet.

From East Kilbride.

15. Sp. Pl. XXI, fig. 10. Brit. Mus., No. 594541, No. 22.

Characters and Size.—Caudal segments and appendages. Ventral aspect. The ultimate segment, tapering from a breadth of about 12 mm. at top to 6 mm. below,

broken across in two places, and damaged by crush at the upper end, was probably 25 mm. long. It is marked with long linear chevrons, pointing obliquely downwards (backwards) from the sides, and meeting along the middle (characterising the ventral aspect). The interstitial spaces bear delicate, transverse, sinuous lines. A fragment of the crushed penultimate segment remains.

There are remains of three broad tail-spines (the fragments being 5, 5, and 7 mm. long). The middle one (style) is sulcate and flattened. The stylets are strongly striated with six costulæ; they are broader than the style. The heads of all three are crushed together under the terminal arch of the ultimate segment (more clearly seen in the photograph).

This specimen differs from that in fig. 4 (ventral aspect) of the same plate, and fig. 4, Pl. XXXI, in both size and shape, being larger. Nevertheless it is probably closely related to it (*D. testudinea*).

Some resemblance to the above-described may be seen in the smaller segments and trifid appendage of the Upper Silurian *Ceratiocaris compta* (pl. VII, figs. 10 *a*, *b*, p. 57, 'Monogr. Foss. Phyllop.,' Pal. Soc., 1888). In this, showing its dorsal surface, the oblique lines of ornament converge forwards (upwards on the figure), and not backwards.

The specimen under notice has some points of agreement with that shown in M'Coy's figure of his *D. Scouleri* (see Pl. XXV, fig. 6 *a*), but we do not associate it with that species, for the relative measurements of the few perfect portions do not agree closely enough, and there are doubtful details in the fig. 6 *a*.

From East Kilbride. Paton Collection.

16. Sp. (?) Mus. Geol. Surv. Scotl., F $\frac{xx}{7\ (bis)}$, No. 22 *m*, 998 B (not figured).

A caudal extremity consisting of two abdominal segments and three tail-spines, showing the ventral aspect. They are all very much crushed, but the fragmentary segments show linear ornamentation like that in fig. 10, Pl. XXI. The spines are coarsely striate, as also in fig. 10.

From the Calciferous Sandstone group; Leet Water, below Hirsel, Coldstream. In dark grey, micaceous, calcareous shale.

17. Rhachura (Dithyrocaris?) venosa, *Scudder*, 1878. Plate XXIX, fig. 4. (Copied from Scudder's fig. 3, op. cit. infra.)

Rhachura venosa, *Scudder*, 1878. Proceed. Boston Soc. Nat. Hist., vol. xix, pp. 296—299, pl. ix, figs. 3, 3 *a*.

— — *Packard*, 1883. Monogr. N.-Amer. Phyllop., p. 452.

Rachura venosa,	*E., W., and J.*, 1888.	Rep. Brit. Assoc. for 1887, p. 63.
—	— *Packard*, 1889.	Proc. Boston Soc. N. H.,[1] vol. xxiv, p. 212.
—	— *Miller*, 1889.	N.-Amer. Geol. Pal., p. 556.
—	— *Vogdes*, 1893.	Bibliogr. Pal. Crust., p. 405.

At page 299 of his memoir on this interesting fossil, the author writes:

"Impression of a dorsal shield in the same nodule . . . showed that it possessed a carapace resembling that of *Dithyrocaris* in general form. It was broadly rounded in front, and its periphery had a broad flat margin, which was covered, at least laterally, with very frequent, delicate, but distinct, slightly incurved, uniform ridges, nearly parallel to the longitudinal axis of the body, and to one another. The specimen is too [much] broken to show anything of the eyes or of any other feature excepting two low longitudinal ridges marked by a sharp carina, slightly curved, opening inward, one in the middle of either lateral half of the body."

The measurements appear to be as follow in comparison with those of M'Coy's *D. Scouleri* (Pl. XXV, fig. 6 *a*), and the caudal extremity in Pl. XXI, fig. 10:

Rhachura venosa.	M'Coy's *D. Scouleri.*	*D. testudinea*, Pl. XXI, fig. 10.
Breadth of carapace, 50 mm.	35	—
Breadth of its margin 5·5 mm.	—	—
Greatest distance of lateral ridge from the inner edge of the margin on one side, 10 mm.; on the other, 8·5 mm.	—	—
Length of abdominal fragments and appendages (two), 48 mm.	32	45?
Length of antepenultimate segment, 7 mm.	—	6?
Breadth of antepenultimate segment, 9·5 mm.	—	15
Length of penultimate segment, 13 mm.	—	—
Breadth of the same posteriorly, 8·75 mm.	—	—
Probable length of the last segment, 5 [13?] mm.	15	25?
Length of caudal appendage [style], 26 mm.	25	10?
Breadth of the same at the base, 3 mm.	5	3
Breadth of the same in the middle, 2·5 mm.	3	2?
Breadth of the same at the broken tip, 1·2 mm.	—	—
Length of the other appendage [stylet], broken and displaced, 26? mm.	—	—

The illustration (pl. ix, fig. 3, nat. size, and fig. 3 *a* magnified) accompanying Mr. Scudder's descriptive memoir represents the ventral aspect of two broken abdominal segments, and two caudal spines (a style apparently and a broken stylet, both sulcate). The shield or carapace is not illustrated. From the comparison of the measurements tabulated above, this specimen appears to belong to a distinct species, but of its generic status we cannot offer an opinion, except that it is probably a *Dithyrocaris*. At page 297, Mr. Scudder states that the lines of ornament on the dorsal surface of the abdominal joints of *Rhachura* are ordinary raised ridges; or, if in reverse, they appear as impressed lines or furrows which

[1] Dr. A. S. Packard has here given some notes on two specimens of this Phyllocaridan obtained by Dr. R. R. Gurley from the Middle Coal-measures of Danville, Illinois. The fragments of the carapace indicate that it was "of a general oval-triangular shape," and "a little over three inches long." Two bayonet-like spines attached to the terminal segment are 15 mm. long.

branch more or less from one another. On the antepenultimate they "converge by running, in a curving course, towards the anterior outer embossed angles of the segment,[1] or join others that do."

The specimen came from a black limestone of the Coal-measures at Danville, Illinois. Referred to "No. 14" bed of the Coal-measures of Vermilion County, Illinois, in Bradley's 'Geology of Illinois,' vol. iv, pp. 224–7.

18. Dithyrocaris carbonaria, *Meek and Worthen*, 1870. Plate XXIX, figs. 5 *a*, *b*, and 6. (Copied from M. and W., figs. 1 *a* and 1 *b*, op. cit. infra.)

Dithyrocaris carbonarius, *Meek and Worthen*, 1870. Proceed. Acad. Nat. Sci. Philadelphia, vol. xxii, p. 55.
— — — 1873. Geol. Surv. Illinois, vol. v (Geol. and Paleont.), p. 618, pl. xxxii, figs. 1 *a*, 1 *b*.
— — *C. A. White*, 1884. Thirteenth Rep. Dept. Geol. Nat. Hist. Indiana, p. 178, pl. xxxix, fig. 2.
— (carbonaria, fide *J. P. Lesley*), *C. E. Hall*, 1876. Proceed. Amer. Philos. Soc., vol. xvi, No. 6, p. 56.
— carbonaria, *S. A. Miller*, 1877. Pal. Foss. America, p. 217; and 1889, North-Amer. Geol. and Paleont., p. 545.
— — *E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886 (1887), p. 63.
— — *J. P. Lesley*, 1889. Dict. Foss. Pennsylv., p. 212.
— — *A. W. Vogdes*, 1893. Bibliogr. Palæoz. Crust., p. 382.

Size { In fig. 6 (M. and W.'s fig. 1 *b*, nat. size); ventral aspect:
Style (including head or caudal plate) 22 mm. long, and 4 mm. wide at the top.
Stylets 22 mm. long when perfect, and 4 mm. wide.

Characters.—The proximal parts of a caudal trifid. The spines appear to have been relatively short and thick. The style is bayonet-shaped and smooth; sectional areas are given with M. and W.'s fig. 1 *a* for the upper and lower portions. The stylets are coarsely striate on the proximal moiety, with 5—7 costulæ; and have only smooth mid-ribs on their distal halves. The style was probably rather shorter than the stylets, but they are all broken at the tips.

From the Middle Coal-measures at Danville, Illinois; and the Coal-measures of Warren County, Pennsylvania.

[1] Analogues of these radiate knobs may be seen in the abdominal segments of *Ceratiocaris Murchisoni*, fig. 4 *a*, pl. iii, 'Monogr. Brit. Pal. Phyll.,' part i, 1888.

19. Dithyrocaris Kochi, *Ludwig*, 1864. Plate XXIX, figs. 7, 8. (Copied from Ludwig's figs. 1 and 1 *a*, nat. size, op. cit. infra.)

Dithyrocaris Kochi, *Ludwig*, 1864. Palæontographica, vol. xi, p. 309, pl. l, figs. 1, 1 *a*, 1 *b*, 1 *c*.
— — *J. M. Clarke*, 1884. N. Jahrb., 1884, vol. ii, p. 185.
— — *E., W., and J.*, 1887. Rep. Brit. Assoc. for 1886, p. 66.

Size.—Fig. 7 { Style and head (caudal plate) 25 mm. long. Stylets 24 mm. long. Dorsal aspect. } As figured, with ends restored.

Pl. XXIX, fig. 7, is Ludwig's figs. 1 *a* (nat. size) and 1 *c*; fig. 8 is his figs. 1 (nat. size) and 1 *b*.

The stylets coming out below the caudal plate and spreading out sideways, appear to reach further than the style.

Characters.—These caudal spines are strong and more or less bayonet-shaped. The style is rather shorter than the stylets. All are represented as having on both faces a central ridge, with striæ on the sloping sides, pointing obliquely downwards and towards the middle. On the style and stylets the ridge is rugose on the dorsal surface; so is the ridge of the style on the ventral face, and possibly that of the stylets also.

Devonian. From the Goniatite-shales, near Herborn, in the Dillthal, Nassau.

20. Dithyrocaris breviaculeata, *Ludwig*, 1864. Plate XXIX, fig. 9. (Copied from Ludwig's fig. 2, nat. size, op. cit. infra.)

Dithyrocaris breviaculeata, *Ludwig*, 1864. Palæontogr., vol. xi, p. 310, pl. l, fig. 2.
— — *J. M. Clarke*, 1884. Neues Jahrb., 1884, vol. ii, p. 185.
— — *E., W., and J.*, 1888. Rep. Brit. Assoc. for 1886 (1887), p. 65.

Size { Style (including the head, which is 6 mm. long and 5 mm. wide) 15 mm. long. Stylets 15 mm. long.

Characters.—The figure shows the ventral surface; the style mid-ribbed and transversely striate; and the stylets with mid-ribs simply. The style is shorter than the stylets, and the latter are spread out sideways. This trifid seems to have the same essential features as those of *D. Kochi*, Ludwig; but it is smaller and the style is relatively blunter and shorter.

Devonian. From the Spirifer-sandstone of Butzbach, Nassau.

21. Dithyrocaris Kayseri, *J. M. Clarke*, 1884. 'Neues Jahrb. f. Min.,' &c., 1884, p. 185, pl. iv, fig. 6.

This, one of the largest sets of tail-spines known for the genus, is much crushed and imperfect. The best-preserved stylet measures at least 50 mm. in length, and is 12 mm. wide near its top. The style was very much larger and longer (the fragment is 100 mm. long, and nearly 20 mm. wide at top, and 7 mm. wide at its broken end. All three spines are uniformly convex, tapering to sharp ends, and are delicately striate longitudinally.

From the Upper Devonian of Wildungen, Germany.

Mesothyra.—Some very large forms of an allied genus, from the Devonian strata of North America, must be here referred to. The genus *Mesothyra* differs from *Dithyrocaris* especially in having a narrow plate along the hinge-area between the dorsal edges of the two valves.

1. Mesothyra Neptuni, *Hall*, 1863.

Dithyrocaris neptuni, *Hall*, 1863. Sixteenth Annual Report of the New York State Cab. of Nat. Hist., Appendix D, p. 75, pl. i, fig. 9.
— — — 1876. Palæontology of New York, vol. v, part 2 Illustrations of Devonian Fossils (published in advance of the Pal. New York), pl. xxiii, fig. 6.
— — *Miller*, 1877. Amer. Pal. Foss., p. 217.
— — *Packard*, 1883. Monogr. N.-Amer. Phyllop.; Twelfth Ann. Report U.S. Geol. Surv., p. 452, fig. 73.
— — *E., W., and J.*, 1888. Rep. Brit. Assoc. for 1887, p. 65.
Mesothyra neptuni, *Hall and Clarke*, 1888. Palæont. New York, vol. vii, with Supplement to vol. v, part 2, p. 191, pl. xxxii, fig. 7; and pl. xxxiii, fig. 1.
— — *Miller*, 1889. North American Geol. and Palæont., p. 556.
— — *Vogdes*, 1893. Bibliogr. Pal. Crust., p. 299.
— — *Clarke*, 1893. American Naturalist, Sept. 1st, 1893, p. 796.

Size { Caudal plate (27 mm. wide) and telson [style] 81 mm. long.
Cercopods [stylets] 110 mm. long.
Style (from its joint in the caudal plate) 75 mm. long, and 15 mm. wide at top.
Stylets 120 mm. long, and 15 mm. wide at top. } As figured.

Characters.—Style (telson) broad, stout, and tapering; shorter than the stylets. The inner margin of the stylets is fringed with setæ.

2. Mesothyra oceani, *Hall and Clarke*, 1888.

Dithyrocaris neptuni, *Hall*, 1876. Illustr. Devonian Foss., pl. xxii, figs. 1—5, pl. xxiii, figs. 1—3.
— — *E., W., and J.*, 1888. Report Brit. Assoc. for 1887, p. 65.
Mesothyra oceani, *Hall and Clarke*, 1888. Geol. Surv. New York, Palæont., vol. vii, p. 187, pl. xxxii, figs. 1—6; pl. xxxiii, figs. 1—7; pl. xxxiv, figs. 1—5.

Size { Carapace-valve (including posterior spine) 140 mm. long, and 60 mm. wide.
Caudal plate and telson [style including head] 67 mm. long.
Cercopods [stylets] 70 mm. long.
Carapace-valve 150 mm. long, and 65 mm. wide.
Style 72 mm. long; wide at head, 24 mm. } As figured.
Stylets 84 mm. long; wide at top, 13 mm. }

Characters.—Stylets vary in length, but are longer than the style. Setæ are attached to the inner margin of the stylets.

One Devonian specimen that has been referred to *Dithyrocaris* may be here noticed.

Ptychocaris? Jaschei (*F. A. Roemer*, 1855). Plate XXIX, figs. 15 *a*—*c*; and 16 *a*, *b*.

Dithyrocaris Jaschei, *F. A. Roemer*, 1855. Palæontographica, vol. v, p. 8, pl. ii, figs. 13 *a*—*c*; and vol. xiii, 1866, p. 219, referring to Roemer's Beitrag III, pl. xvii [ii], fig. 13 (misspelt *Ditryocharis*).
Dithyrocaris? Jaschei, *Kayser*, 1878. Abhandl. Geol. Specialkarte von Preussen und Thüringischen Staaten, vol. ii, Heft 4, p. 7, pl. i, figs. 13, 13 *a*.
— Jaschei, *J. M. Clarke*, 1884. N. Jahrb., 1884, vol. i, p. 185.
— ? — *E., W., and J.*, 1888. Report Brit. Assoc. for 1887, p. 66.
Ptychocaris? Jaschei, *E., W., and J.*, 1889. (After Novák.) Rep. Brit. Assoc. for 1888, p. 124.

Roemer's figures (reproduced Pl. XXIX, figs. 15*a*—*c*) of this obscure fossil may possibly be referable either to a portion of a bivalved carapace, with a median dorsal ridge (or hinge-line), or to a single convex valve, with a *lateral* longitudinal ridge such as that of *Ptychocaris;* in either case filled with matrix, and broken across. Being convex and ridged on one face, and nearly flat on the other, it shows a flattened subelliptical (Roemer's) or suboval (Kayser's) section. It has an ornament of straight and inosculating striæ, connected by oblique striæ, sinuous and traversing the interspaces. This is analogous to the irregular interlinear meshwork in Pl. XVIII, fig. 8, and Pl. XXI, fig. 11.

Dr. Kayser's figures give this little fossil straighter sides, with the ridge oblique, and the section more of a flattened oval shape. The surface bears longitudinal striæ, parallel to the sides, and on one side to the ridge, but slightly oblique to it on the other.

From the Hercynian Limestone (latest Silurian or earliest Devonian) in the Klosterholz, near Ilsenberg, Hartz.

The late Ottomar Novák, in 1888 informed us that this fossil, as figured by Kayser, shows some resemblance to his *Ptychocaris*,[1] which occurs in the equivalent horizon, namely, the "Hercynian" of Beyrich and Kayser = "Étages F, G, and H" of Barrande.

The Gastric Teeth of Dithyrocaris.

In the 'Geological Magazine,' vol. ii (1865), a paper by one of us "On some Crustacean Teeth from the Carboniferous and Upper Ludlow Rocks of Scotland" describes and illustrates some of these curious little fossils. At page 401 it is stated that "So long ago as 1843 the late General Portlock (at that time a captain of the Royal Engineers conducting the Geological Branch of the Ordnance Survey of Ireland), in his 'Report on the Geology of the County of Londonderry,' figured the teeth of *Dithyrocaris* in pl. xii, fig. 6, of that work; and at page 315 he observes, "Fig. 6 represents bodies which are frequently found on the specimens of this crustacean, and in this instance together, as represented in the figured specimen, they each exhibit a single row of tubercles, and were in all probability connected with the masticatory apparatus, which it is probable, therefore, was highly developed in this large species." The figure here referred to was reproduced in the 'Geol. Mag.,' pl. xi, fig. 8; but is now much more accurately drawn (from the original specimen) in Pl. XXVI, fig. 44. We

[1] 'Sitzungsb. böhm. Ges. Wiss.,' 1885, pp. 343—346, and plate. This Phyllocarid is related to both *Ceratiocaris* and *Dithyrocaris*.

further extract from pages 401–2 of the above-mentioned paper, "Figs. 3—6 represent the teeth of *Dithyrocaris* collected by Mr. James Armstrong and Mr. J. Bennie from Campsie and East Kilbride, Lanarkshire, and Orchard Quarry, near Thornliebank, Renfrewshire.

"Mr. Bennie was so fortunate as to obtain, at Lickprivick Quarry, East Kilbride, Lanarkshire, a portion of a carapace (pl. xi, fig. 6), upon the under side of which he discovered the long-looked-for teeth *in situ* (figs. 6 *a*, *b*). This discovery is the more acceptable, because the teeth have never yet been met with at Carluke, where the carapaces are found, although the Carboniferous beds have been diligently searched for fossils by Dr. Rankin for at least thirty years; whilst the localities already named as yielding the detached teeth do not furnish remains of the carapace.

"The teeth, with one or two exceptions, always occur in ironstone nodules, and the best specimens are those which have been weathered out. . . . . It is probable that the soft parts of the animal (which contained the teeth), having been, after death, detached from the carapace, became the nucleus for a concretion, such as the phosphatic and ironstone nodules in many other strata. Differences in flotation, and in the force of currents, would account for the scattering of the several parts of the animal.

"Mr. Armstrong informs us that the *Dithyrocaris* tooth from Campsie (pl. xi, figs. 4 and 4 *a*) occurs in a bed of black shale, overlying the 'Hosie Limestone' of the Lanarkshire Carboniferous series, which is about 670 fathoms below the 'Ell Coal,' . . . . the horizon usually taken by the Glasgow geologists in giving the position of Carboniferous fossils. No other specimen is recorded from this locality.

"Its associated fossils are *Nucula gibbosa*, *N. lineata*; *Leda longirostris*, *L. attenuata*; *Nautilus subsulcatus*; *Goniatites Gilbertsoni*, *G. vesica*; a profusion of *Spirifera Urei*, *Orthoceras pygmæum*, and a large *Cythere* (*?*).

"Those from Orchard Quarry, near Thornliebank, Renfrewshire (pl. xi, figs. 3 *a*, *b*, and 5, 5 *a*), are from a bed of shale about 300 fathoms below the Ell Coal. The common fossils in this bed are several species of *Cypricardia*, *Leda*, *Orthoceras*, *Productus costatus*, *Bellerophon Urei*, *B. Leveilleanus*, *Macrocheilus*, *Pleurotomaria monilifera*. No trace of carapace has been discovered at either of these localities.

"The specimen with the teeth attached to the portion of the carapace, from East Kilbride (pl. xi, fig. 6), was found in shale associated with Brachiopoda, corals, &c. The teeth are common at Orchard Quarry, but only a single specimen has been met with either at Lickprivick or Campsie."

These teeth, so fully represented in Pl. XXVI, more nearly resemble those of the lobster than those of Apus in their relative size, solidity, and form (see H. Woodward's paper on "Crustacean Teeth, &c.," in the 'Geological Magazine,'

already quoted above; and the *article* "Crustacea," 'Encyclopædia Britannica,' vol. vi, 1877, p. 639, fig. 13; also Huxley's "Crayfish," 1888, pp. 56—60; Rolleston's 'Forms of Life,' 2nd edit., by Mr. H. Jackson, 1888, pp. 181—184, with full references to other observers; and Howse's 'Atlas of Biology,' pl. ix).

In studying these little fossil teeth they should not lie crosswise, as in our Pl. XXVI, but the narrow and lowest (hinder) end of the tooth (pointing towards the pylorus of the stomach) should be placed downwards, and the convexity will be noticed on one side or the other. The cusps on the broad end (pointing towards the cardiac part of the stomach) are thick and high, those at the narrow end are low; the hinder (pyloric) part of the tooth being more contracted and depressed than the other (cardiac) half, as is markedly the case in the lobster (*Homarus vulgaris*) and crayfish (*Astacus fluviatilis*).

Our specimens are divisible into two groups: No. 1, those that have a convexity on the left hand, as fig. 34, when the narrow or hinder (pyloric) end is placed downwards; and No. 2, those that are convex on the right, as in fig. 20, when so placed. The anterior (cardiac) end of the tooth in Pl. XXVI, fig. 34, points to the right hand of the reader; and in fig. 20 it points to his left hand. For convenience, and indeed according to their relative position in the lobster's stomach, we term No. 1 group the *sinistral*, and No. 2 the *dextral* teeth. Both kinds are present together in fig. 44, the *sinistral* tooth lying upon and against its *dextral* fellow.

These, looking like molar teeth of some sort of the higher animals, have a crown consisting of six or seven cusps on a slightly curved solid basis, thickest in the middle. Four of the cusps on the front (cardiac) half are thick and prominent; but on the other (pyloric) half, two or three seem to have been worn down, leaving a more or less flattened or hollow surface: for instance, figs. 18, 23, 25, and 34 of the left teeth; and figs. 20, 21, 40, and 43 of the right teeth.

There is another tooth in the lobster, namely, the narrow, blunt, hook-like, overhanging *median* tooth (bifid in the crayfish), which works between the hinder flattened surfaces of the two side teeth below.

We have no evidence, however, in *Dithyrocaris* of the upper intervening median tooth, such as is associated with a similar flatness in the hinder part of the side teeth in the stomach of the lobster and crayfish.

The illustrations of Pl. XXVI were made before we had assorted the teeth in the manner above mentioned. We now find that they fall into the following arrangement, as *rights* and *lefts*:

DEXTRALS.

Figs. on Pl. XXVI.

Symbols { Right position. As placed on the plate.

1. 2. 3. } Orchard Quarry.

4. 5. } Campsie.

6. 7. } Orchard Quarry.

13. 14. } Orchard Quarry.

15. 16. } Orchard Quarry.

19. 20. } Newcastle-on-Tyne.

21. 22. } Redesdale.[1]

27. Orchard Quarry.

30. 31. } East Kilbride.[1]

32. Orchard Quarry.

37. 38. } Orchard Quarry.

39. 40. } Orchard Quarry.

43. Dunbar.

One in 44. } Londonderry.[1]

SINISTRALS.

Figs. on Pl. XXVI.

Symbols { Right position. As placed on the plate.

9. 10. } Cowlands Quarry.

11. 12. } Dolly Quarry.

17. 18. } Orchard Quarry.

23. 24. } Redesdale.[1]

25. 26. } Redesdale.[1]

33. 34 } Cock of Arran.

35. 36. } Redesdale.[1]

41. Orchard Quarry.

42. Eccup.[1]

One in 44. } Londonderry.[1]

[1] At these localities the gastric teeth are found under two conditions; some free, and others still within the carapace, as shown by their protruding through the valves.

(All on Pl. XXVI are magnified two diameters, except figs. 1—7.)

By way of making it easy to recognise the relative position of these gastric teeth in the original stomach, as pointing fore and aft (that is, from its cardiac or front to its pyloric or hinder division), we introduce a simple symbol. The crescent refers to the curvature of the tooth, and the little angle, or angular sign, shows at which end the coarser cusps rise out of the tooth.

Thus means a dextral convexity, with the high cusps forward, or towards the cardiac extremity of the stomach; and indicates the sinistral position. On the plate (Pl. XXVI) the dextral teeth occur as and the sinistrals as .

There are probably distinctions due to the relative age of individuals in the collection, but we cannot point with certainty to any specific differences among the figured specimens, except that figs. 33, 34, and 35, 36 (not quite perfect),

having a greater length of tooth, with very distinct and elevated cusps, may probably have belonged to a species of larger growth.

For a description of the Gastric Teeth of *Ceratiocaris*, compared with those of *Dithyrocaris*, see 'Geological Magazine,' dec. 3, vol. v (1888), pp. 145, &c., with illustrations.

NOTES ON DITHYROCARIS.

1. The more simple forms of *Dithyrocaris*, with ovate-oblong and smooth or somewhat granulated valves, supply 53 out of the 144 known British specimens of the genus. These, represented by Nos. 1, 2, and 3 (*D. glabra*, 46; *ovalis*, 1; and *granulata*, 6) in the table at page vii, should probably be regarded as forming a special group in the genus.

2. *D. Scouleri* (No. 5), having doubtful features in some respects (see page 156), had probably a smooth surface, but differs much from the foregoing in form.

3. *D. testudinea* (No. 4) has a speciality in its peculiar ornament of oblique and sinuous striæ passing all over its test (page 145). This is an abundant form, there being 24 known out of the 144 British specimens of *Dithyrocaris*.

4. The reticulate pattern, with modifications, characterises five British species, of which *D. insignis* (No. 7) presents the greatest number of known specimens (36). The Irish *D. Colei* (No. 8) is next most plentiful, but with only 11 specimens. The reticulation is faint in *D. funiculata* (No. 6), Pl. XXII, fig. 6; stronger and irregular in *D. insignis* (No. 7), Pl. XXV, figs. 3 and 5, Pl. XXX, figs. 3 and 4, and Pl. XXXI, fig. 8. In *D. Colei* (No. 8), in *D. tricornis* (No. 10), and probably in *D. orbicularis* (No. 9), the reticulation is emphasised by some of its meshes being produced at the angles into short triangular spines, Pl. XXII, figs. 4, 5 *a*, 5 *d*, 5 *e*, and Pl. XXVII, fig. 4 *e*.

5. Short cross-lines between longitudinal striæ, as in Pl. XXXI, figs. 2 and 4 *d* (*D. testudinea*); and an interstitial network, shown in Pl. XVIII, fig. 8, is present in the Canadian *D. Belli*.

6. Minute punctation, such as is common in crustacean tests, is seen in many specimens, both of the smooth and the reticulate kind. Thus Pl. XVIII, figs. 1 and 3 (*glabra* and *ovalis*); Pl. XX, figs. 2 and 3 (*granulata*); Pl. XXVIII, figs. 3 and 5 *c* (cast), Pl. XXIV, figs. 11 *b* and 12 *d*, and Pl. XXXI, figs. 1—3 (*testudinea*); Pl. XXV, figs. 3—5, Pl. XXVII, fig. 1 *c*, Pl. XXX, fig. 3 *d*, and Pl. XXXI, figs. 7 *b* and 8 *c* (*insignis*); and Pl. XXVII, fig. 2 *c* (*tricornis*).

SOME ALLIES OF DITHYROCARIS.

I. Lebescontia ænigmatica, gen. et sp. nov. Woodcuts, Figs. 11—13.

This was referred to in the "Seventh Report on Palæozoic Phyllopoda," 'Report British Association for 1889' (1890), page 65, as having been collected by M. Paul Lebesconte, of Rennes, from the Lower Silurian rocks of Brittany and neighbourhood, thus:—"M. Lebesconte's Collection, above mentioned, comprises two specimens of *Dithyrocaris*, one from Coësmes (Ille-et-Vilaine) and one from Renazé (Mayenne), both in the 'Schiste ardoisier supérieur (Faune 2de, Barrande),' above the Grès de May."

These are specimens in rather hard, dark-blue, slaty, argillaceous schist, slightly micaceous. One of them (from Coësmes) shows a hollow impression, 45 mm. long by 30 mm. wide, and nearly 2 mm. deep at one part of the border—apparently the hollow mould of a flattened bivalve or shield-like form allied to *Dithyrocaris*, Fig. 11.

The other specimen (from Renazé), of similar slate, has a slight convexity of

Fig. 11. Fig. 12 A. Fig. 12 B. Fig. 13.

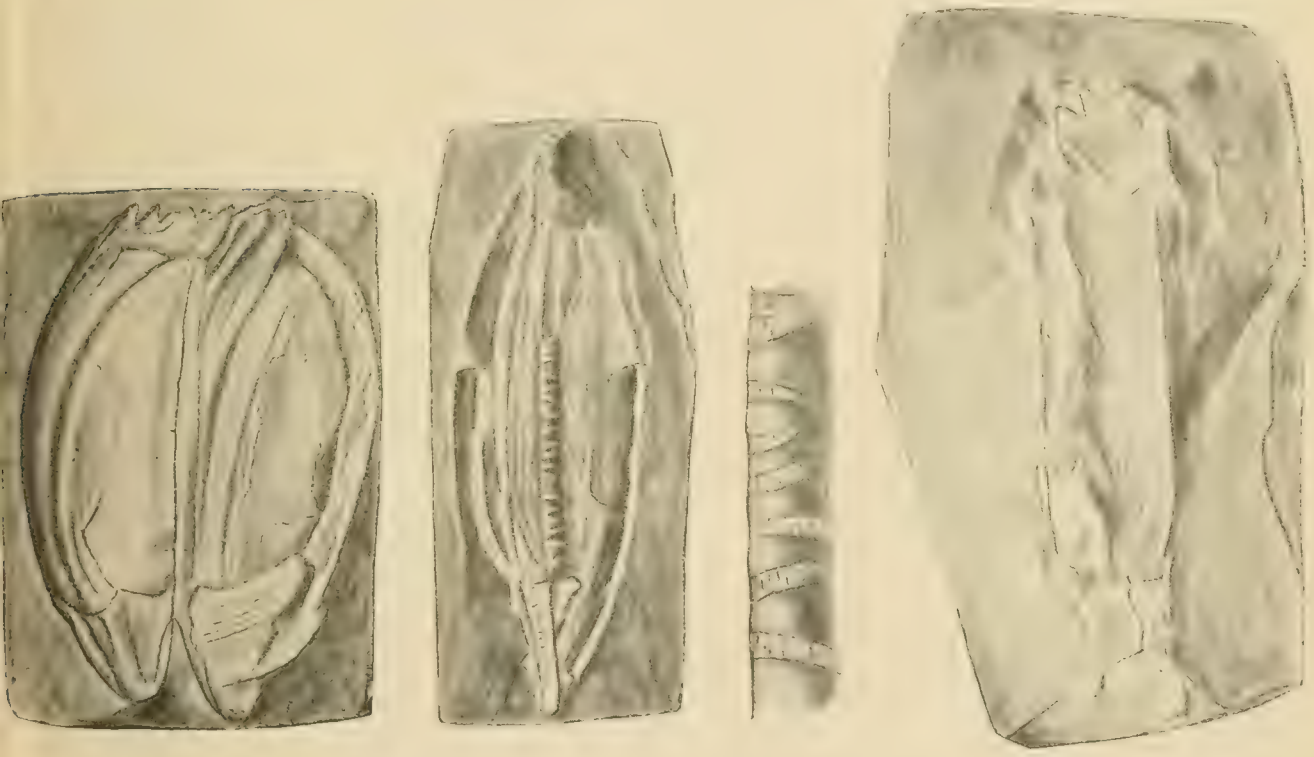

Fig. 11.—*Lebescontia ænigmatica*, gen. et sp. nov. Two flattened valves or moieties. Lower Silurian, Coësmes, Brittany. Magnified 1½ diam.

Figs. 12 A, B.—*Lebescontia ænigmatica*. A. Dorsal aspect. Lower Silurian. Magnified 1½ diam. B. Raised or thickened dorsal ridge. Magnified 7 diam. Lower Silurian, Renazé, Anjou.

Fig. 13.—*Lebescontia ænigmatica*. Crushed right valve. On the back of the same specimen of slate that contains Fig. 12. Magnified 1½ diam. Lower Silurian, Renazé, Anjou.

organic origin on each face, but not exactly corresponding one with the other in position, size, or shape. One side shows a distinct form (Figs. 12 A, 12 B), like that of the dorsal edge of a *compressed* bivalved form (50 mm. by 23 mm.); the other side shows a flatter and less shapely organism (Fig. 13), like a portion of the crushed valve of a Dithyrocarid.

Fig. 11.—The concave specimen on the slaty schist from Coësmes shows either an *impression* of the *outside* of two expanded valves, or at least partially (as indicated to some extent here and there by traces of a black shining film) the *inside* of the two valves. The cast of matrix once filling the cavity, and bearing probably some other details of the animal's structure, has been lost.

This has some analogy to specimens of flattened valves of *Dithyrocaris* illustrated in Pls. XVIII and XXVIII.

In the two flattened valves (Fig. 11) the dorsal edges are in contact; not quite clearly defined, however, one from the other, on account of a partial overlap, or some other discordance, along the middle line. They open out one from the other at the ends, but more definitely at one end than the other. Both of the extremities have been damaged.

Being greatly though unequally flattened by pressure, they present an aspect comparable, as far as general outline is concerned, with fig. 5 *a*, Pl. XXVIII, which is an impression of the outer surface of the expanded valves of *Dithyrocaris testudinea*; also to some extent with figs. 3 *a* and 6 of Pl. XVIII, illustrating the outside aspect of the expanded valves of *D. ovalis* and *D. granulata*. The fuller lateral curve, however, is in the anterior rather than in the posterior portion.

The upper end in Fig. 11 has a serrated edge, which has only a feeble homologue in figs. 1, 4, and 6 of Pl. XVIII, and in fig. 3 of Pl. XXII.

At the lower end of Fig. 11 each valve narrows much more quickly than in any of our other figured species of *Dithyrocaris*, and does not bear clear evidence of the usual ventral terminal spines; if ever present, they have been lost, or crushed out of recognition.

The longitudinal foldings or wrinklings of the test in each valve are probably homologous with those in *Calyptocaris striata*, Pl. XVII, fig. 7, and *C. Richteriana*, Pl. XXII, fig. 2. The ends of the valves in these two figured species are too imperfect for comparison with those of *Lebescontia*.

Figs. 12 A and 12 B.—On the hand-specimen from Renazé, the more distinct fossil of the two, lying back to back, suggests at first sight a comparison with the dorsal aspect of a closed bivalved test of some Dithyrocarid, compressed, but retaining some lateral convexity (Fig. 12 A). It has a terminal appendage, or blunt spike, overlying a displaced portion of the hinder end of the right valve. The posterior process differentiates this form from Fig. 11, unless it has been lost in the latter.

The upper end of Fig. 12 A retains no evidence of the denticulate margin

seen in Fig. 11. The surface of the valves is longitudinally wrinkled and striate, as in Fig. 11.

The hinge-line is straight, and shows a thick subcylindrical body, crenulate or marked with small alternately light and dark triangles. Its anterior moiety, having been broken away, has left in the matrix an impression of the oblique segments of this seemingly *quasi*-spiral, rod-like structure, which at first sight seems to be the edge of the right valve.

In such other Dithyrocarids as figs. 1, 2, and 3 of Pl. XX, figs. 1, 2, and 6 of Pl. XXIV, figs. 1, 2, 4, 6, and 9 of Pl. XXV, and fig. 3 of Pl. XXX, we find a narrow rugose hinge-plate or dorsal ridge having little or no analogy to this dorsal rod-like structure in Figs. 12 A and 12 B.

Perhaps this long, narrow, subcylindrical body may be the remains of the straight intestinal canal, distended with food at the time of the death of the little animal.[1] Barrande has described and figured the dorsal aspect of a specimen of *Trinucleus Goldfussi* with the intestinal canal open throughout its length; and of another, with the contents of the intestine indicating its whole extent, "Syst. Silur. Bohême," 'Recherch. Paléont.,' vol. i, 1852, p. 629, pl. xxx, figs. 38 and 39. In a Scotch specimen we have lately found an analogous structure, formed by the union of narrow folds on the dorsal margins, see Fig. 14. (See NOTE at page 203.)

FIG. 13.—This seems to be a much-crushed and imperfect right-hand valve of a Dithyrocarid, with two raised lines, one of them apparently dorsal, and the other (mesolateral) near the ventral margin, which is partly broken away, but once ended with a strong spine. Another but smaller spine is present on the posterior border. The anterior margin is strongly dentate, as in Fig. 11.

As already stated, although occupying the back of the hand-specimen on which Fig. 12 A is embedded, it does not appear to belong to the latter, not being exactly behind it, and being flatter, and differently shaped.

Combining the evidences given by these specimens, although they are somewhat obscure on account of imperfection, distortion, and embedment (Figs. 11—13), we may conclude that they are the relics of some kind of bivalved or shield-like Phyllopod, near to but not identical with *Dithyrocaris*.

Fig. 11 has the general contour of such a test, with some trace of anterior prickles, but no posterior spines (possibly they may have been lost). Fig. 12 A, differently posed, shows no prickles at its imperfect front end, but has a posterior spine and a curious dorsal structure (Fig. 12 B). The longitudinal ridges, folds, and striæ present in all three, Figs. 11, 12, and 13, are also found in some Dithyrocarids.

Hence it is proposed to arrange this fossil, though difficult of interpretation,

[1] It has been suggested as a possible interpretation of the cylindrical body on Fig. 12 A, and enlarged in Fig. 12 B, that it may be a part of some other organism accidentally associated with the valves of *Lebescontia*, such as a crinoid stem or a serpulite tube; both of which kinds are found in these schists (of course altered in character, as such slate fossils usually are).

as a new genus of the *Dithyrocaridæ* under the appellation of LEBESCONTIA, after the well-known geologist of Rennes, who discovered it in the Lower Silurian schists of Brittany, and lent the specimens to one of us several years ago for examination and description. Its obscure and complex character suggests ÆNIGMATICA for its specific name. The locality and geological horizon indicate that these specimens are the oldest known individuals of this group of *Phyllopoda*.

In the Report of the 'Association Française pour l'Avancement des Sciences, Congrès de Nantes, 1875,' MM. Gaston Le Goarant de Tromelin and Paul Lebesconte gave an account of the Palæozoic Formations of the north-west of France, with lists of the Silurian fossils of the Departments of Maine-et-Loire, Loire-Inférieur, and the Morbihan ('Compte-rendu du Congrès,' &c., published in June, 1876, pp. 601—687).

The palæozoic rocks of the "massif breton ou armoricain," which constitutes the great peninsula of North-western France, have been studied in more or less detail by many geologists, and the memoir mentioned above refers to their work, and gives the result of the special researches by MM. de Tromelin and Lebesconte up to 1875. In 1889 M. Lebesconte kindly lent his collection of the palæozoic fossils of Brittany to one of us, and the phyllopodal specimens here figured and described were noticed among them as being probably allied to *Dithyrocaris*.

In the 'Memoir' by de Tromelin and Lebesconte no particular fossils are recorded from Coësmes, Dép. Ille-et-Vilaine (Brittany); but in the Collection above referred to there are obscure remains of Molluscan bivalves, of Trilobites and Eurypterids, also the Dithyrocarid under notice, and one or more specimens of *Coleoprion*.

Renazé, whence one of our specimens came, is just south of Brittany, in the ancient province of Anjou, not far from the border of the Département de Maine-et-Loire, but in the Dép. de la Mayenne. It is in a line with the slate quarries of Riadan[1] and Coësmes (Ille-et-Vilaine). In Table A of MM. de Tromelin and Lebesconte's 'Memoir' the following fossils are recorded from the slaty schist of Renazé:

Calymene pulchra, *Barrande*.
Dalmanites socialis, var. proæva, *Barr*.
Trinucleus Goldfussi, *Barr*.
— ornatus, *Sternberg*, sp.
— Pongerardi, *Rouault*.
Ampyx tenellus, *Barr*.
Illænus Beaumonti, *Rouault*, sp.
Acidaspis Buchi, *Barr*.
Serpulites Letellieri, *Tromelin*.
Ctenodonta Ciæ, *Sharpe*, sp.
— Eschwegei, *Sharpe*, sp.

[1] In the 'Proceedings of the Geologists' Association,' vol. xxi, pt. 3 (July, 1899), p. 111, the Riadan Slates are referred to the Middle Ordovician Series by Dr. C. Barrois; and at page 132 he refers to 'Bull. Soc. Géol. France,' ser. 3, vol. xiv (1886); and 'Annales Soc. Géol. du Nord,' vols. i to xvii, Lille, for literature on the Geology of Central Brittany.

Orthis Berthoisi, *Rouault.*
— mundæ, *Sharpe.*
— noctilio, *Sharpe.*
— Ribeiroi, *Sharpe.*

Encrinites Andegavensis, *Trom. and Leb.*
Petraia ? insolita, *Trom. and Leb.*

In M. Lebesconte's Collection the following, besides the Dithyrocarid, were observed from Renazé:—genal and pleural spines of Trilobites, Eurypterid fragments, Crinoid stems (Triacrinus), part of an arm of an Asteriad (Loriolaster ?), Pteropodal (?) shells, also remains of Brachiopods and of Molluscan bivalves.

Note.—It is possible that Fig. 12 A does not represent a truly bivalved test, but that the two moieties of a flat carapace have been squeezed horizontally into a narrow boat-shape.

II. Lebesconta occulta, sp. nov. Woodcuts, Figs. 14, 15, and 16.

Fig. 15.

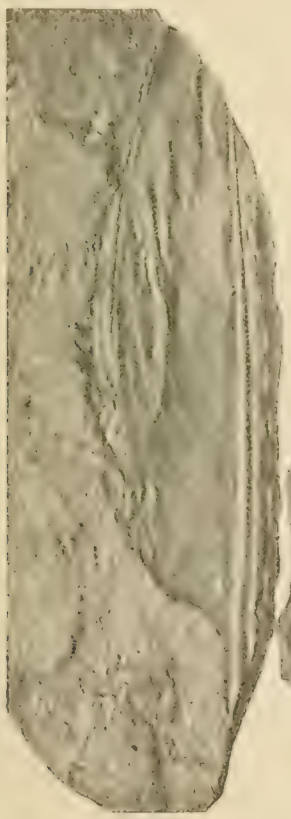

Fig. 14.

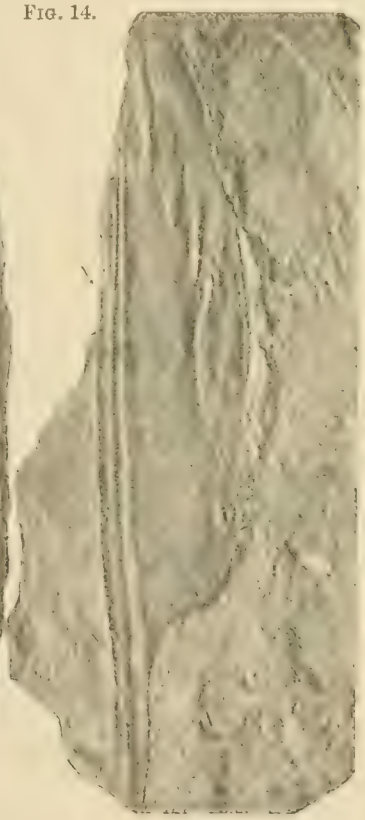

Fig. 16 A.

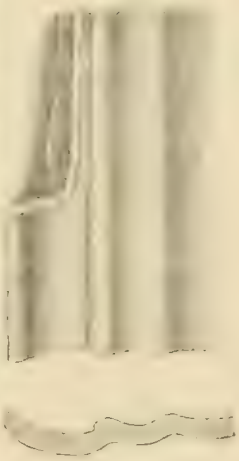

Fig. 16 B.

Fig. 14.—*Lebescontia occulta*, sp. nov. Right moiety of carapace, magnified 1½ diam.
Fig. 15.—*Lebescontia occulta*, sp. nov. Counterpart, showing the impression of the right valve, Fig. 14; probably the loss of the outermost film has exposed the striæ more distinctly; magnified 1½ diam.
Figs. 16 A, B.—Part of the structure of the dorsal margin, where the arrow points in Fig. 14; magnified 10 diam.

Since describing M. P. Lebesconte's Breton specimens, Figs. 11, 12, 13, at page 199, we have met with, among some Carboniferous fossils lent to us by Mr.

John Smith, of Kilwinning, two counterparts[1] of a dithyrocaridal valve, which has a remarkable similitude in some respects to *L. ænigmatica*.

1. Fig. 14 represents a nearly perfect right-hand valve in its lateral aspect. It is 75 mm. long by 15 mm. broad, of a pod-like shape,[2] nearly straight dorsally, and shallow-elliptical on its ventral margin. This is most convex in the middle, and narrows more obliquely at the compressed anterior extremity; the edge, however, is broken away at both ends. The middle third of the ventral border is markedly smooth, being probably a flange, turned in and pressed flat. A delicate rugose ridge lies along and within the middle part of the ventral edge, with a rather less curvature, and with its ends running into that border at about a fourth of the length of the valve from each of its extremities.

The dorsal edge is neatly bent along its length into a narrow fold (Fig. 16 B), which possibly overlaps a corresponding fold of the other valve, with some matrix intervening. Where broken, this arrangement has the appearance of a gutter filled with dry mud. It is not subcylindrical as in the analogous structure in *L. ænigmatica* (Fig. 12, page 199), but flattened. As a junction of the two valves, it is not compatible with a free motion of one or the other; but rather indicates a nearly flat and shield-like condition of the carapace. The upper part of this flat gutter-like hinge-structure may possibly be homologous, in some degree, with the *middle piece* in the *Rhinocaris* and *Mesothyra* of North America.

On the surface of the valve four or five oblique folds of limited extent mark the anterior moiety; and the remainder seems to be smooth, except for some very faint striæ, which are far better pronounced in Fig. 15. There is a definite posterior elongation of the dorsal border, as a stout process, not unlike, but more slender than, that shown in Fig. 12 A. It has been almost lost in Fig. 15.

2. The other counterpart (Fig. 15) is more imperfect at the ends than Fig. 14, and measures 55 mm. by 15 mm. It agrees with Fig. 11 in general shape, and in showing a straight and peculiarly folded dorsal margin. The short oblique crumpling, on the front part of the valve, and the little rough ridge (impression) near the ventral margin, and which may represent the *mesolateral* in *Dithyrocaris*, are characteristic. The surface also exhibits numerous delicate, curved, parallel striæ, starting as it were in the antero-ventral region, at first crowded, and nearly parallel with the ventral edge, but turning upwards and backwards, and feathering off, with widening interspaces, towards the dorsal border. This delicate sculpturing must have been nearly lost on the other counterpart (Fig. 14) by the removal of an outer film of the shell.

[1] A specimen consisting of two counterparts, and in so far analogous to Figs. 14 and 15, was figured in Pl. XXI, figs. 7 *a*, 7 *b*, and described at p. 158 as casts of the left-hand moiety of a carapace of probably *Dithyrocaris Scouleri*.

[2] Somewhat like that of *Rhinocaris bipennis*, J. M. Clarke, 'Geol. Survey State of New York,' 1896, p. 69.

These (Figs. 14 and 15) very rare representatives of a peculiar form occur in a hard, bluish, calcareous shale, with numerous fragments of shells. Several *Posidonomyæ* lie on the back of one counterpart, and *Aviculopecten* abounds on the bed-plane at the back of the other. Mr. John Smith collected them at the Linn, Dalry, in the "Upper Limestone" series, twenty miles south-west of Glasgow.

The presence of a peculiar hinge-structure is a striking feature, as in *L. ænigmatica;* the pod-shape, though narrower and more graceful,—the striæ more strongly represented than in Fig. 13,—the *mesolateral*, smaller than in Fig. 13, are links between the two species, and supply distinctive characters for this one, which may be termed OCCULTA, for it is not yet defined in a clear light.

The longitudinal crumple or fold of the dorsal edge may be hidden in the middle line of Fig. 11, and underneath that of Fig. 12 A. It does not seem to be traceable in any species of *Dithyrocaris*. It might possibly have some analogy to the mid-dorsal, longitudinal, thin piece, which is part of and intermediate to the junction-line in the valves of the *Rhinocaridæ*.[1]

III. HIBBERTIA ORBICULARIS, *Jones and Woodward*. Plate XXV, figs. 8 *a*, 8 *b*.

HIBBERTIA ORBICULARIS, *Jones and Woodward*, 1899. Geol. Mag., dec. 4, vol. vi, p. 390, pl. xv, fig. 4.

This small Crustacean shield was presented to the British Museum many years ago by our late friend Dr. John Millar, F.G.S., of Bethnal House, Bethnal Green. The specimen is embedded in a finely laminated, micaceous, non-calcareous shale (bluish-grey in section), and bears the label "Coal M., Burdiehouse." It was at first believed to be one of Dr. Hibbert's types from Burdiehouse, but nothing like this fossil was found to have been figured or mentioned in Dr. S Hibbert's memoir[2] on the strata and fossils of Burdiehouse; therefore its occurrence there, as shown by its old label, is of great interest.

It was described and figured in the 'Geological Magazine' for September, 1899, as indicated above.

Generic and Specific Characters.—A nearly circular shield, 14 mm. broad by 15 mm. long, having an opening behind, which is bounded by two acute incurved angular spines, forming the backward extremities of the concentric shield or buckler-like test. The periphery of the concentric part of the test is turned up sharply as a thin rim in the fossil, leaving a uniform narrow groove behind it,

[1] See Mr. J. M. Clarke's description of this "median plate" in 'The American Naturalist,' September 1st, 1893, pp. 793—801, and the 'Fifteenth Annual Report of the State Geologist, New York,' 1896, p. 69.

[2] 'Trans. Roy. Soc. Edinburgh,' vol. xiii (1836), p. 280, plates.

from which the field of the buckler rises with a gentle swelling over and along the crescentic area, except where the edge falls in for a little space just on the centre of the front border. Where the buckler becomes slightly depressed and the narrow groove along the margin is interrupted or perhaps injured there is an obscure impression of what may be a jointed antennary organ in front. The surface of the two lateral areas of the buckler have a finely granulated ornamentation, which is most marked just within the peripheral rim of the carapace, and is limited by two thin parallel granulated ridges, each starting from the incurved posterior angles of the shield, the longest being 7 mm. and the shortest only 4 mm. in length; the intervening space of 5 mm. in breadth, marking the centre of the carapace, is devoid of the granulated ornament seen on the other parts of the shield, and has only a small spine-like impression 3 mm. long, and extending for three quarters of the entire length of the shield as a curved irregular incised line. There are some other markings, too obscure for interpretation; also a slight posterior projection on the central line, doubtfully representing part of a lost series of caudal segments.

The presence of the two corresponding angles, and the narrow posterior opening between them, suggest affinities with *Dithyrocaris* (cf. *D. Scouleri* as represented by M'Coy, Pl. XXV, fig. 6*a*, with its two raised lateral ridges), but in most of the members of this group the lateral portions of the shield are less circular in outline, and in many the surface-ornamentation is composed of linear or reticulate, and only occasionally of granulate markings. Compared with the shield of *Apus* or *Lepidurus*,[1] the general outline is much alike, but the granulated mesolateral ridges continued forward from each of the posterior angles in *Hibbertia* are not present in *Apus*, whereas the median ridge so conspicuous in both *Apus* and *Dithyrocaris* is apparently quite absent in *Hibbertia*, or is not preserved in the fossil. Contrasted with the anterior (cephalic) buckler in *Limulus*, the shield of *Hibbertia* is seen to be nearly circular, whilst that of *Limulus* is semicircular; the posterior angles of the shield of *Hibbertia* are contracted together and directed somewhat inwards at their extremities, whilst in *Limulus* they are wide apart and directed rather outwards. The mesolateral (ocular) ridges are present both in *Hibbertia* and in *Limulus;* but in *Limulus* they form a smooth, curved, broad line, not a nearly straight ridge as in *Hibbertia*.

The granulation on the lateral areas of the shield and on the ridges is also strange to *Apus*, and more closely resembles that seen in some species of the Carboniferous genus *Cyclus* (cf. *Cyclus Johnsoni*, H. Woodw.,[2] and *C. testudo*, Peach,

[1] See Dr. S. A. Packard's 'Monograph of the Phyllopod Crustacea of North America,' 1883, pl. xvi, fig. 1, *L. glacialis*.

[2] See "Contributions to our Knowledge of the Genus *Cyclus* from the Carboniferous Formation of various British Localities," by H. Woodward, 'Geol. Mag.,' dec. 4, vol. i, 1894, pp. 530—539, pl. xv.

the former from the Coal-measures of Coseley, near Dudley, the latter from the Carboniferous shales—so rich in Crustacea, Arachnida, &c.—of Eskdale on the Scottish borders).[1]

None of the earlier fossil forms of Limuloid Crustaceans hitherto figured and described, of which a series may be studied on pl. xxxi, figs. 1—8, 'Monograph of the Merostomata,' Palæont. Soc., part v, 1878, aid us in finding a suitable form for comparison with the shield of *Hibbertia*, nor do the larval stages of the recent *Limulus* greatly assist in this direction (op. cit., pl. xxxiii). We are therefore reduced to the conclusion that *Hibbertia* may be more conveniently placed along with and near to those forms referred to the genus *Cyclus* than with any other group. Under these circumstances we preferred to regard it as characteristic of a distinct genus; and named it after Dr. Hibbert, with whose discoveries in the Lower Carboniferous strata at Burdiehouse it is most closely associated.

From the paper on *Cyclus* by H. Woodward, already referred to, we make the following extract (pages 534 and 535), to show the conclusions arrived at by the writer as to the affinities of the curious little forms included in the genus *Cyclus*. To the same family our specimen from Burdiehouse must now be added under the name of *Hibbertia*.

"The presence of antennæ and biramous swimming-legs prove undoubtedly that *Cyclus* was a Crustacean. The large size of the former and the homogeneous nature of the rest of the appendages (all biramous swimming-legs, with possibly masticatory bases), taken in connection with the large, slightly bivalved carapace, suggest that it is an Entomostracan and probably one of the Phyllopoda, with a broad cephalic carapace like that possessed by *Apus* and by *Daphnia*; with large swimming second antennæ like the latter, and possibly with a pair of stalked eyes. *Cyclus*, however, differs from the Cladocera in being flattened dorso-ventrally, and from the lowest Crustacea in not apparently possessing any true jaw-parts—the head, with the labrum and mouth, being bent further back than in the living Entomostraca. These differences may either indicate very lowly characters or very much specialised ones. Two views suggest themselves:

"(1) That these animals were small, free-swimming Phyllopods, with expanded cephalic shield, swimming second antennæ, and biramous limbs, the bases of which served as masticatory organs, no true jaws having yet been developed; the backward position of the mouth may have been brought about in order to allow as many appendages as possible to serve as jaws, as is seen in *Limulus*. Or, possibly, the beast could attach itself, like a living *Daphnia*, by a cement-gland on the dorsal side of the head, in which case it might be an advantage to have the mouth as near the freer end as possible and close to the swimming legs, which were, by their movements, producing the foot-currents.

[1] 'Trans. Roy. Soc. Edinburgh,' vol. xxx (1883), p. 227, pl. xxviii, figs. 9—9 *d*.

"(2) The other view is that these animals were ecto-parasitic Phyllopods, although they had not lost their power of free movement, yet had become specialised in the form of their body, which is flattened ventrally and only slightly convex above, the whole animal being expanded horizontally, unlike most other Phyllopods. This view might account for the two large round structures seen on the ventral surface, situated one on either side of the body, and close to the anterior margin of the shell. These might possibly represent a pair of ventral suckers, such as are seen in the modern fish-lice; these structures, whatever they may be, are evidently enormously developed, and possess great muscles, which produce prominent modifications of the dorsal shield, where they are attached. The great labrum might possibly represent the suctorial tube of *Argulus*, under cover of which are concealed the reduced mandibles, &c.

"Some of the specimens show curious oblique scars on the coxæ of the legs, which may indicate the points of attachment of spines or setæ to enable the parasite to stick to its fishy host."

NOTE ON *Lebescontia occulta* (see pages 203—205).

Mr. John Smith, of Kilwinning, informs us (September 5th, 1899) that the "Linn, Dalry," where he got the remains of *Lebescontia occulta*, is the "Linn Spout, one mile south-west of Dalry," in the 'Catalogue of Western-Scottish Fossils,' 1876, page 77; and he refers us to the paper on "The Upper Limestone of North Ayrshire," by Mr. Robert Craig, of Beith, 'Trans. Geol. Soc. Glasgow,' vol. viii, pp. 28—35. At page 32 the "Upper Linn Limestone" is described, the section at Linn Spout being—

	Feet.	Inches.
1. Limestone	35	0
2. Shale, very fossiliferous	5	9
3. Limestone	1	0
4. Shale, full of *Posidonomya punctatella* . . .	0	8
5. Limestone	1	2
6. Shale, indurated	1	3
7. Coal, from 2 feet to	5	0
	49	10

The *Lebescontia* was collected by Mr. J. Smith in the shale, No. 4, abounding with a fossil shell formerly known as *Estheria punctatella*, Jones. See the 'Trans. Geol. Soc. Glasgow,' vol. ii (1867), p. 71, and vol. ix (1891), pp. 85—87. Hence this shale has been known locally by the inaccurate name of the "Estheria-bed." It is regarded by some as of estuarine origin.

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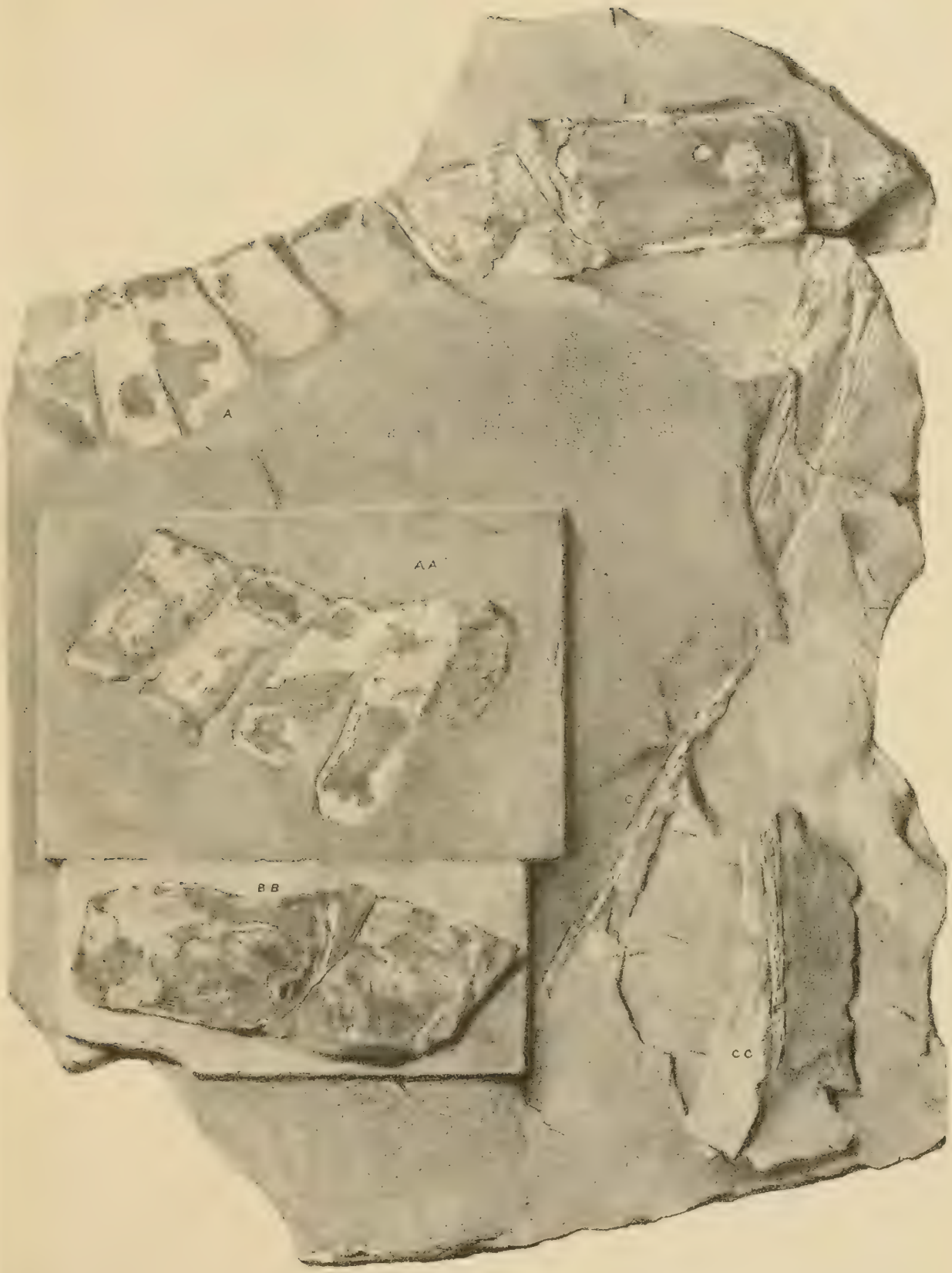
PLATE I.

CERATIOCARIS LUDENSIS, *H. Woodward.*

Seven abdominal segments, and imperfect caudal spines. With three portions shown in reverse. Two-thirds of the natural size. See also Plate IX, fig. 1 *a*, natural size. Ludlow Museum. (Page 32.)



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BRITISH FOSSIL PHYLLOPODA

PLATE II.

CERATIOCARIS HALLIANA, *T. R. J. & H. W.* Natural size.

Fig. 1.—Carapace. Mus. Pract. Geol. (Page 26.)

Fig. 2.—Carapace, segments, and a portion of the appendages. Mus. Pract. Geol. (Page 27.)

Fig. 3.—Carapace and segments. Mus. Pract. Geol. (Page 28.)

Fig. 4.—The same (?). Carapace, segments, and caudal appendages. (Possibly *C. tyrannus.*) Mus. Pract. Geol. (Page 27.)

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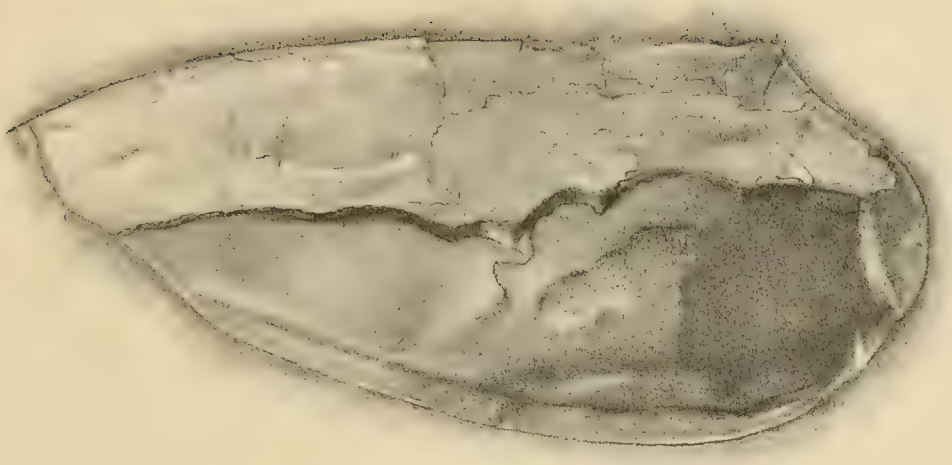

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BRITISH FOSSIL PHYLLOPODA

PLATE III.

(All the figures are of natural size except fig. 4 *b*, which is one and a half natural size.)

Fig. 1.—*Ceratiocaris gigas*, Salter. Ultimate segment and a portion of the appendages. Mus. Pract. Geol. (Page 24.)

Fig. 2.—*C. tyrannus*, Salter. Four segments and the distal portion of the appendages. Mus. Pract. Geol. (Page 22.)

Fig. 3.—The same. Four segments and the proximal portion of style and stylet. Mus. Pract. Geol. (Page 23.)

Fig. 4.—*C. Murchisoni* (Agassiz). 4 *a*, four segments and appendages; 4 *b*, one of the segments enlarged (half as much again) to show its ornament. Mus. Pract. Geol. (Page 16.)

Fig. 5.—*C. tyrannus*, Salter. Small; five segments and imperfect appendages. Mus. Pract. Geol. (Page 23.)

Fig. 6.—The same. Small; four segments and the appendages. British Museum. (Page 23.)

Fig. 7.—*C. Murchisoni* (Agassiz). Two stylets. Mus. Pract. Geol. (Page 18.)

Fig. 8.—*C. tyrannus* (*?*), Salter. Fragment of the anterior moiety of a right valve. Mus. Pract. Geol. (Page 23.)

Fig. 9.—*C. cassioides*, T. R. J. & H. W. Carapace and imperfect abdominal segments. British Museum. (Page 59.)

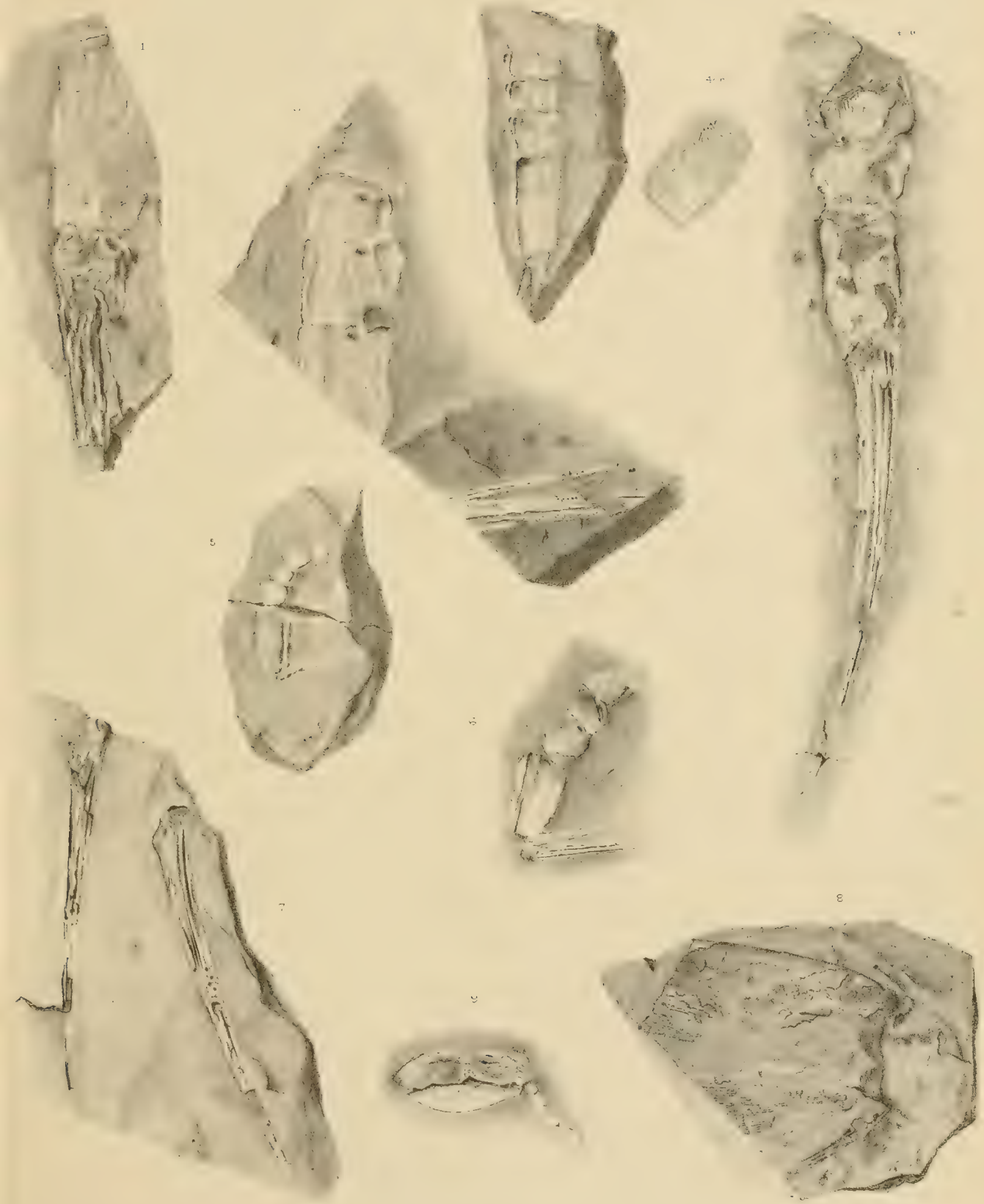

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PLATE IV.

(All the figures are of the natural size.)

Fig. 1.—*Ceratiocaris Murchisoni* (Agassiz). The three caudal spines. Oxford Mus. (Page 18.)

Fig. 2.—*C. gigas*, Salter. Ultimate segment and the appendages, not quite perfect. Oxford Mus. (Page 25.)

Fig. 3 —*C. Murchisoni* (Agassiz). The three appendages, not quite perfect. Oxford Mus. (Page 19.)

Fig. 4.—*C. tyrannus*, Salter. Seven segments, and fragments of the appendages. Oxford Mus. (Page 23.)

Fig. 5.—*C. Halliana* (*?*), T. R. J. & H. W. Very small. Carapace and two segments. Oxford Mus. (Page 29.)

Fig. 6.—The same (?). T. R. J. & H. W. Very small. Carapace and six segments. Oxford Mus. (Page 29.)

Fig. 7.—*C. cassioides*, T. R. J. & H. W. Carapace, four segments, and telson. Oxford Mus. (Page 60.)

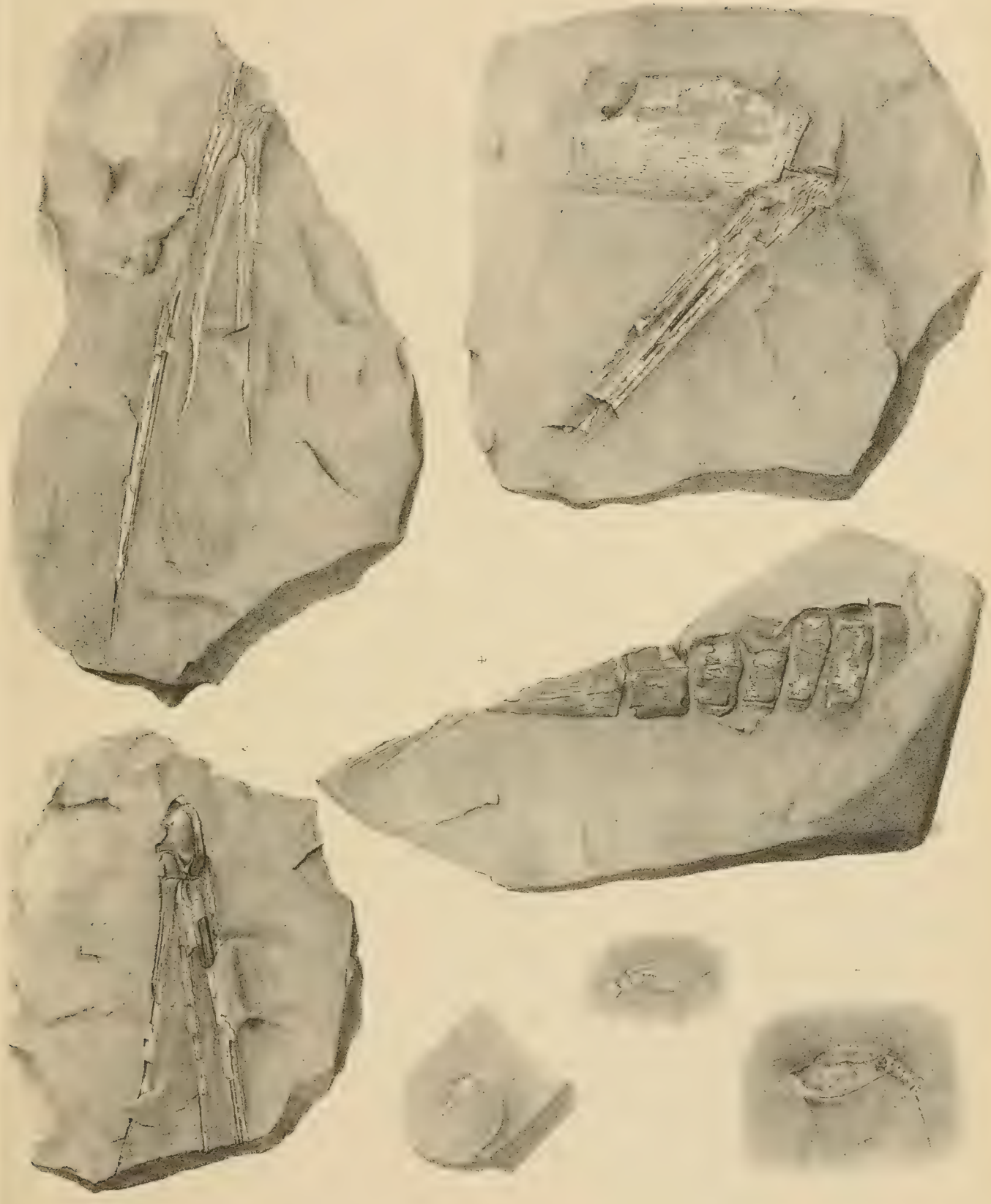

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PLATE V.

(All the figures are of the natural size except fig. 6 *b*, which is magnified three and a half times, and 7 *c* and 7 *d*.)

Fig. 1.—*Ceratiocaris Pardoëana*, La Touche. Carapace (with rostrum), six (?) segments, and proximal portion of the caudal appendages. Ludlow Mus. (Page 30.)

Fig. 2.—The same. Carapace and six segments, with the proximal portion of the caudal spines. Ludlow Mus. (Page 31.)

Fig. 3.—*C. Murchisoni* (Agassiz). Caudal spines, imperfect. Ludlow Mus. (Page 19.)

Fig. 4.—*C. tyrannus*, Salter. Four segments and imperfect caudal appendages. Ludlow Mus. (Page 24.)

Fig. 5.—*C. gigas*, Salter. Ultimate segment. Ludlow Mus. (Page 25.)

Fig. 6.—*C. Halliana* (?), T. R. J. & H. W. Small. 6 *a*. Carapace, eight segments, and caudal spines, imperfect. (Possibly *C. tyrannus*.) Ludlow Mus. 6 *b*, part of a segment enlarged ($3\frac{1}{2}$ diameters) to show the ornament. (Pages 22 and 29).

Fig. 7.—*Xiphocaris ensis* (Salter). 7 *a*, the telson; 7 *b*, its sectional area; 7 *c*, enlarged border of the convex edge; 7 *d*, enlarged border of the concave edge. (Page 65.)

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BRITISH FOSSIL PHYLLOPODA.

PLATE VI.

(All the figures are of the natural size except fig. 4 *b*, magnified 3 diameters, and fig. 4 *c*, 2 diameters.)

Fig. 1.—*Ceratiocaris Murchisoni* (Agassiz). (Type specimen.) Broken caudal spines, copied from 'Siluria,' 1867, pl. 19, fig. 1. (Specimen lost.) (Page 19.)

Fig. 2.—The same. Imperfect head of a telson. Copied from 'Siluria,' 1867, pl. 19, fig. 2. (Specimen lost.) (Page 19.)

Fig. 3.—*C. longa* (?), T. R. J. & H. W. A stylet. Copied from 'Siluria,' 1867, pl. 19, fig. 3. (Specimen lost.) (Page 43.)

Fig. 4.—*C. leptodactylus*, M'Coy. (Type specimen, fig. 7 in 'Brit. Pal. Foss.,' 1855.) 4 *a*, a telson with piece of the ultimate segment; 4 *b*, portion of the telson, with pits, enlarged 3 diameters; 4 *c*, enforced contact of the telson and ultimate segment, magnified 2 diameters. Cambridge Mus. (Page 15.)

Fig. 5.—*C. leptodactylus*, M'Coy. (Original of fig. 7 *a* in 'Brit. Pal. Foss.,' 1855.) A telson, imperfect. Cambridge Mus. (Page 15.)

Fig. 6.—The same. Part of an ultimate segment and of a telson (?). Mus. Pract. Geol. (Page 15.)

Fig. 7.—The same. Three caudal spines, not quite perfect. Mus. Pract. Geol. (Page 15.)

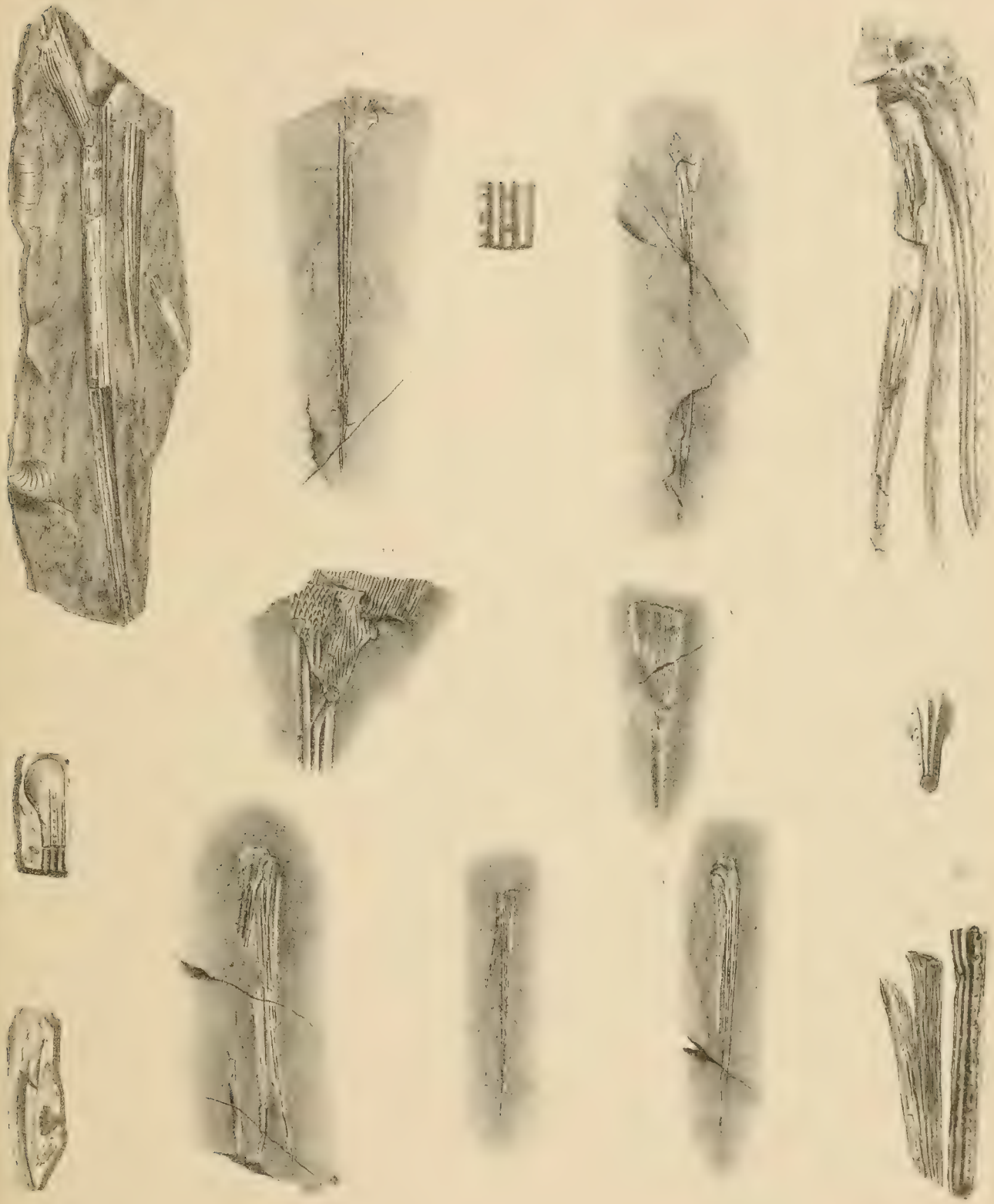
Fig. 8.—The same. Caudal spines, imperfect. Mus. Pract. Geol. (Page 16.)

Fig. 9.—The same. Style and stylet. Mus. Pract. Geol. (Page 16.)

Fig. 10.—*C. valida*, T. R. J. & H. W. Three caudal spines (not quite perfect), with a fragment of the ultimate segment Copied from the 'Geol. Mag.,' vol. iii, pl. 10, fig. 8. Dudley Mus. (Page 21.)

Fig. 11.—The same. Portion of three caudal spines. Copied from the 'Geol. Mag.,' vol. iii, pl. 10, fig. 9. Mus. Pract. Geol. (Page 21.)

Fig. 12.—*C. Bohemica*, Barrande. Dorsal view of the head of a telson. Copied from the 'Geol. Mag.,' vol. iii, pl. 10, fig. 10, for comparison. British Mus. (Page 21.)



HYLLOPC A

PLATE VII.

(All the figures are of the natural size except figs. 7 *b*, 7 *d*, 7 *e*, and 9 *b*.)

Figs. 1 *a*, 1 *b*.—*Ceratiocaris Salteriana*, T. R. J. & H. W. The counterparts of a squeezed carapace. Mus. Pract. Geol. (Page 55.)

Fig. 2.—The same. A carapace. Cambridge Mus. (Page 55.)

Fig. 3.—The same. A carapace, abdominal segments, and caudal appendages. Oxford Mus. (Page 56.)

Fig. 4.—*Ceratiocaris cassioides*, T. R. J. & H. W. Carapace, abdomen, and appendages. Ludlow Mus. (Page 60.)

Fig. 5.—The same. Carapace, abdomen, and appendages. Oxford Mus. (Page 61.)

Fig. 6.—The same. Carapace, abdomen, and appendages. Mus. Pract. Geol. (Page 60.)

Figs. 7 *a*—7 *e*.—*Ceratiocaris cassia*, Salter. Counterparts of a small slab, each having remains of two carapaces (neither quite perfect, and the lower one narrowed by pressure) with abomen and appendages. 7 *a*, Ludlow Mus.; 7 *c*, Mus. Pract. Geol.; 7 *b* (× 4 diam.), a piece of the ventral rim and striæ from 7 *a*; 7 *d* and 7 *e* (× 4 diam.), similar pieces projecting from the upper borders of the carapaces; 7 *d*, from upper specimen in fig. 7 *c*; and 7 *e*, from the lower specimen. (Page 58.)

Fig. 8.—*Physocaris vesica*, Salter. 8 *a*, the specimen in Mr. Salway's collection at Ludlow; 8 *b*, copied from the woodcut in the 'Ann. Mag. Nat. Hist.,' 1860. In both cases the carapace is probably upside down. (Page 67.) (See also the woodcut, Page 67.)

Fig. 9.—*Emmelezoe tenuistriata*, T. R. J. & H. W. 9 *a*, carapace partly embedded above and broken below; 9 *b*, portion of the linear ornament (× 15 diam.), placed vertically instead of horizontally. Ludlow Mus. (Page 70.)

Fig. 10.—*Ceratiocaris compta*, T. R. J. & H. W. 10 *a*, remains of carapace, abdomen, and appendages; 10 *b*, part of abdomen and appendages, magnified 3 diameters. Ludlow Mus. (Page 57.)

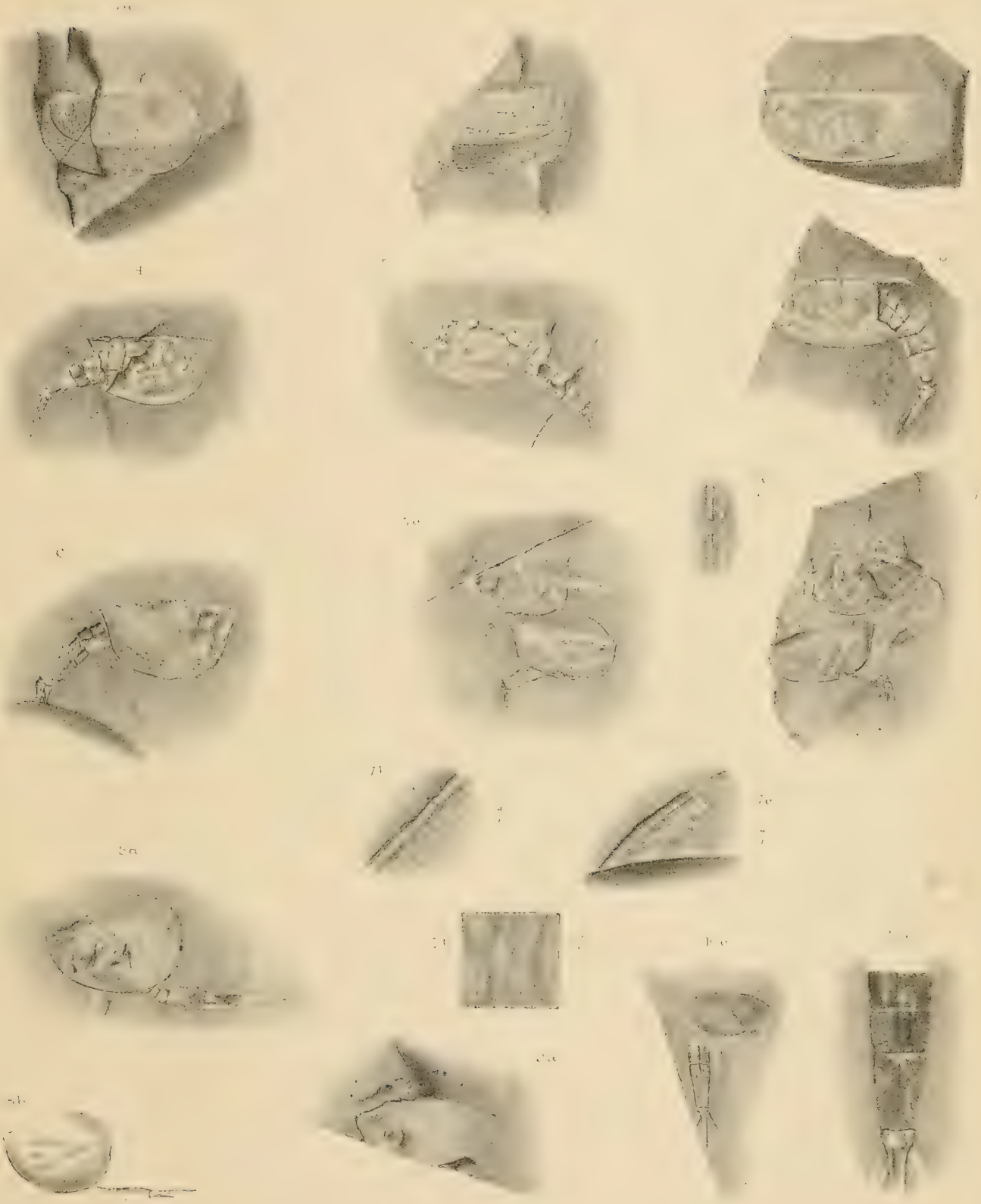


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PLATE VIII.

(All the figures are of the natural size except figs. 11 *b*, 11 *c*.)

Figs. 1 *a*, 1 *b*.—*Emmelezoe elliptica*, M'Coy. 1 *a*, left valve; 1 *b*, end view. Cambridge Mus. (Page 69.)

Figs. 2 *a*, 2 *b*.—*E. Maccoyiana*, T. R. J. & H. W. 2 *a*, right valve; 2 *b*, end view. Mus. Pract. Geol. (Page 71.)

Figs. 3 *a*, 3 *b*.—*E. crassistriata*, T. R. J. & H. W. 3 *a*, right valve; 3 *b*, end view. Mus. Pract. Geol. (Page 70.)

Figs. 4 *a*, 4 *b*.—*Ceratiocaris solenoides*, M'Coy. 4 *a*, dorsal aspect of an imperfect and partly embedded carapace; 4 *b*, end view of one of the valves. Cambridge Mus. (Page 53.)

Fig. 5.—The same. Right valve partly embedded in the matrix. Cambridge Mus. (Page 53.)

Fig. 6 *a*, 6 *b*.—*C. gobiiformis*, T. R. J. & H. W. 6 *a*, right valve; 6 *b*, end view. British Mus. (Page 54.)

Figs. 7 *a*, 7 *b*.—*C. solenoides*, M'Coy. Original of fig. 5 in 'Brit. Pal. Foss.,' 1855. 7 *a*, right valve; 7 *b*, end view. Cambridge Mus. (Page 53.)

Figs. 8 *a*, 8 *b*.—The same. Short variety. 8 *a*, left valve, imperfect; 8 *b*, end view. Cambridge Mus. (Page 53.)

Figs. 9 *a*, 9 *b*.—The same. Short variety. 9 *a*, left valve, partly embedded; 9 *b*, end view. Mus. Pract. Geol. (Page 53.)

Figs. 10 *a*, 10 *b*.—The same. Long form, like 7 *a*. 10 *a*, left valve; 10 *b*, end view. Cambridge Mus. (Page 53.)

Figs. 11 *a*, 11 *b*, 11 *c*.—*C. gobiiformis*, T. R. J. & H. W. 11 *a*, right valve, natural size; 11 *b*, the same, magnified 2 diam.; 11 *c*, end view, × 2 diam. Cambridge Mus. (Page 54.)

Fig. 12.—*C. laxa*, T. R. J. & H. W. Carapace, abdomen, and caudal appendages, complete. (A piece of the delicate striation is shown, magnified 25 diam., in Plate X, fig. 12.) British Mus. (Page 56.)

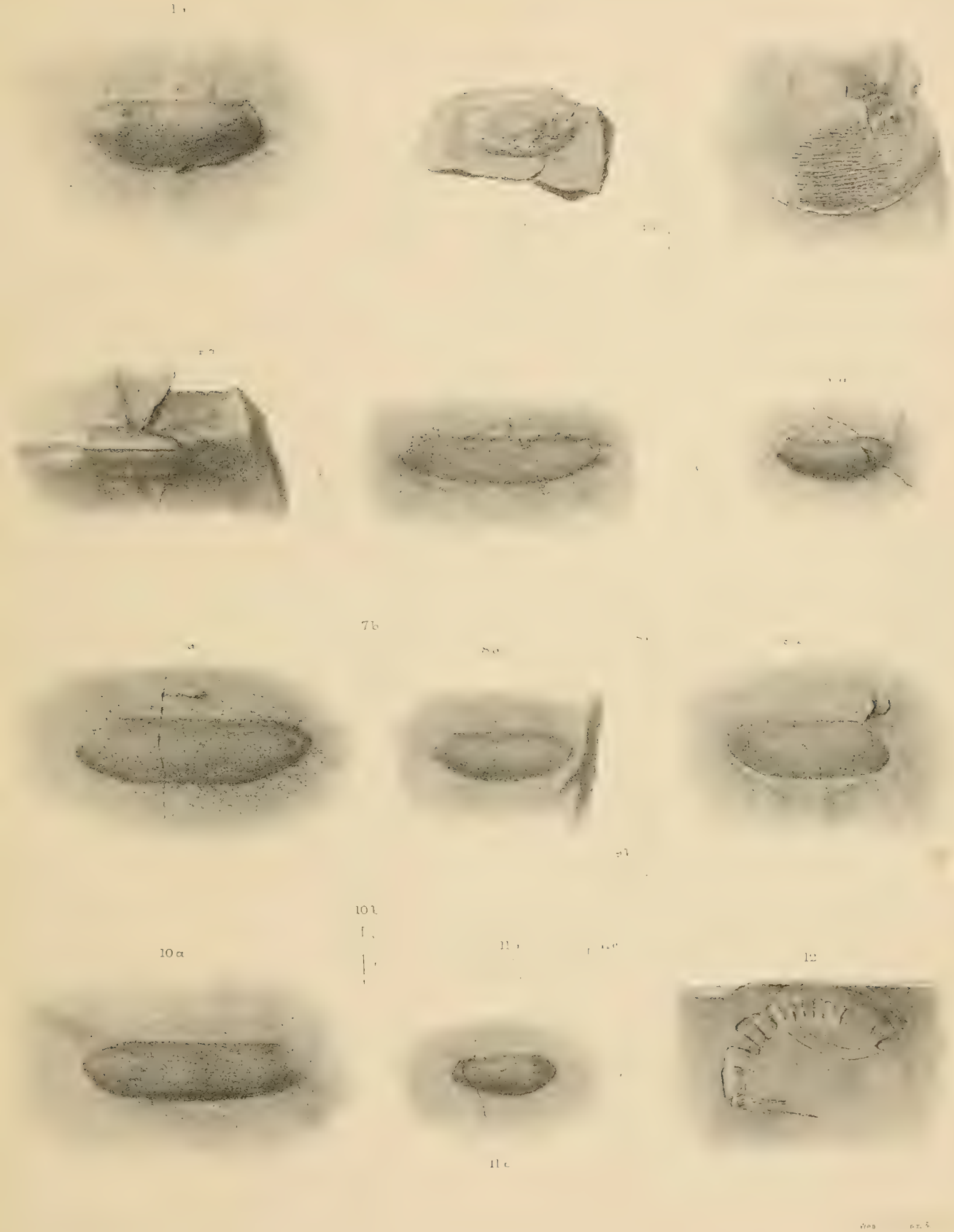

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PLATE IX.

(All the figures are of the natural size except fig. 1 *b* and fig. 4.)

Fig. 1.—*Ceratiocaris Ludensis*, H. Woodward. (See also Plate I.) 1 *a*, two segments and the caudal appendages (imperfect) of the natural size; 1 *b*, the terminal portion of the spine E, D, C. enlarged twice. Ludlow Museum. (Page 34.)

Fig. 2.—*C. canaliculata*, T. R. J. & H. W. Upper portion of a telson, crushed and broken. Mr. Cocking's collection, Ludlow. (Page 31.)

Fig. 3.—The same. Fragments of an ultimate segment and a telson. Mus. Pract. Geol. (Page 31.)

Fig. 4.—*C. tyrannus* (?), Salter. An abdominal segment (imperfect), enlarged 4 diam., to show its ornament. On the back of the slab with *Physocaris vesica*, Pl. VII, fig. 8, in Mr. T. J. Salwey's collection, Ludlow. (Page 24.)

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BRITISH FOSSIL PHYLLOPODA.

PLATE X.

(All the figures are of the natural size except fig. 7 *b* and fig. 12.)

Figs. 1 *a*, 1 *b*.—*Ceratiocaris truncata*, H. Woodward. Left valve: 1 *a*, the internal cast; and 1 *b*, the hollow impression; counterparts. British Mus. (Page 51.)

Fig. 2.—*C. inornata*, M'Coy. Right valve. British Mus. (Page 48.)

Fig. 3.—The same. Right valve. The specimen figured in the 'Brit. Pal. Foss.,' 1851, fig. 4. Cambridge Mus. (Page 49.)

Fig. 4.—*C. Oretonensis*, H. Woodward. Left valve. British Mus. (Page 50.)

Fig. 5.—*C. inornata*, M'Coy Right valve. British Mus. (Page 48.)

Fig 6.—*C. Ruthveniana*, T. R. J. & H. W. Right valve, imperfect. British Mus. (Page 49.)

Figs. 7 *a*, *b*.—*C. stygia*, Salter var. 7 *a*, right valve; 7 *b*, portion enlarged (2 diam.) to show the longitudinal striation on the upper and lower regions of the valve. Cambridge Mus. (Page 41.)

Fig. 8.—*C. leptodactylus* (?), M'Coy. Portion of the abdomen, probably part of the penultimate and ultimate segments. British Mus. (Page 16.)

Fig. 9.—*C. angusta*, T. R. J. & H. W. Style and stylet. British Mus. (Page 47.)

Fig. 10.—*C. robusta*, Salter. Trifid appendage. Mus. Pract. Geol. (Page 44.)

Fig. 11.—*C. minuta*, T. R. J. & H. W. Trifid appendage. Owens College Mus. (Page 47.)

Fig. 12.—*C. laxa*, T. R. J. & H. W. Portion of the linear ornament, magnified 25 diam. (see Pl. VIII, fig. 12). British Mus. (Page 57.)

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PLATE XI.

(All the figures are of the natural size except figs. 4 *b*, 13 *b*, and 16 *b*.)

Fig. 1.—*Ceratiocaris stygia* (?), Salter. Two abdominal segments, with a style and a stylet, well preserved. Cambridge Mus. (Page 41.)

Fig. 2.—*C. longa*, T. R. J. & H. W. Caudal extremity (wanting one stylet), flattened. Ludlow Mus. (Page 43.)

Fig. 3.—*C. stygia*, Salter. Two abdominal segments, style, and stylet, squeezed sideways. Mus. Pract. Geol. (Page 41.)

Figs. 4 *a*, 4 *b*.—*C. papilio*, Salter. 4 *a*, four segments, style, and stylet, squeezed sideways; 4 *b*, portion of leaf-like ornament (× 3 diam.). Oxford Mus. (Page 38.)

Fig. 5.—*C. longa*, T. R. J. & H. W. One segment, style, and stylet, like fig. 2. Mus. Pract. Geol. (Page 43.)

Fig. 6.—*C. papilio*, Salter. Four segments and trifid appendage, pressed flat. British. Mus. (Page 38.)

Fig. 7.—*C. stygia*, Salter. Two segments with telson and stylet, pressed sideways. Oxford Mus. (Page 41.)

Fig. 8.—*C. robusta*, Salter. Telson and stylet, squeezed sideways. The original of fig. 7 *e*, 'Brit. Pal. Foss.,' 1851. Cambridge Mus. (Page 45.)

Fig. 9.—The same. A stylet. The original of fig. 7 *d* in the 'Brit. Pal. Foss.,' 1851. Cambridge Mus. (Page 45.)

Fig. 10.—*C. minuta* (?), T. R. J. & H. W. A trifid appendage, not quite perfect at the top. Mus. Pract. Geol. (Page 47.)

Fig. 11.—*C. patula*, T. R. J. & H. W. A flattened trifid of broad caudal spines. Oxford Mus. (Page 46.)

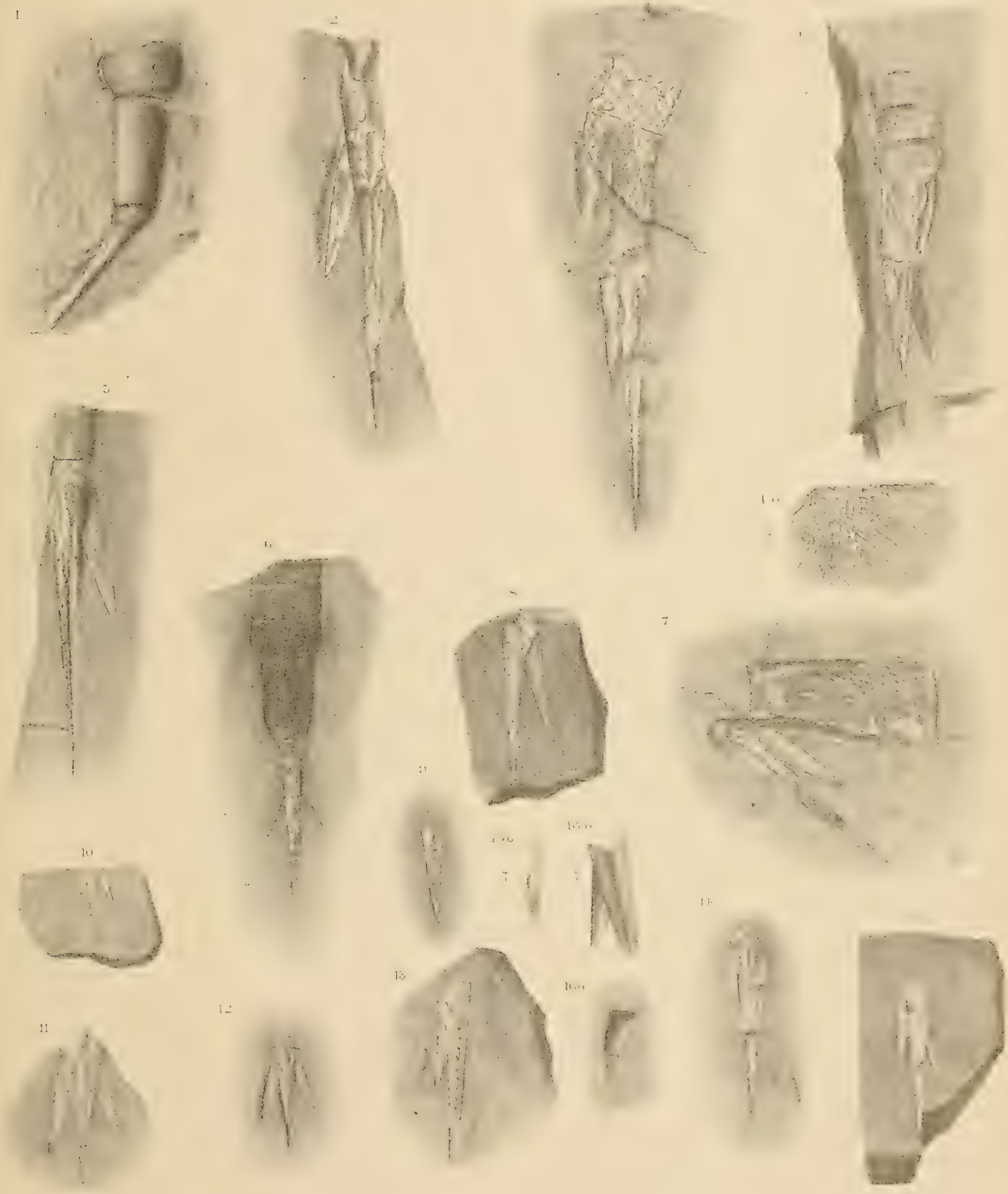
Fig. 12.—*C. robusta* (?), Salter. Cast of a trifid appendage (small). British Mus. (Page 45.)

Figs. 13 *a*, 13 *b*. *C. robusta*, Salter. 13 *a*, style and stylet, pressed sideways. 13 *b*, portion of the pitted row, magnified 3 diam. British Mus. (Page 45.)

Fig. 14.—The same. Style and displaced stylet. British Mus. (Page 45.)

Fig. 15.—The same. A perfect trifid, flattened. British Mus. (Page 46.)

Figs. 16 *a*, 16 *b*. *Ceratiocaris* (?) *longicauda*, D. Sharpe. Portugese specimen. 16 *a*, ultimate segment and trifid appendage; 16 *b*, part of the style and of a stylet enlarged × 3 diam. (Page 61.)



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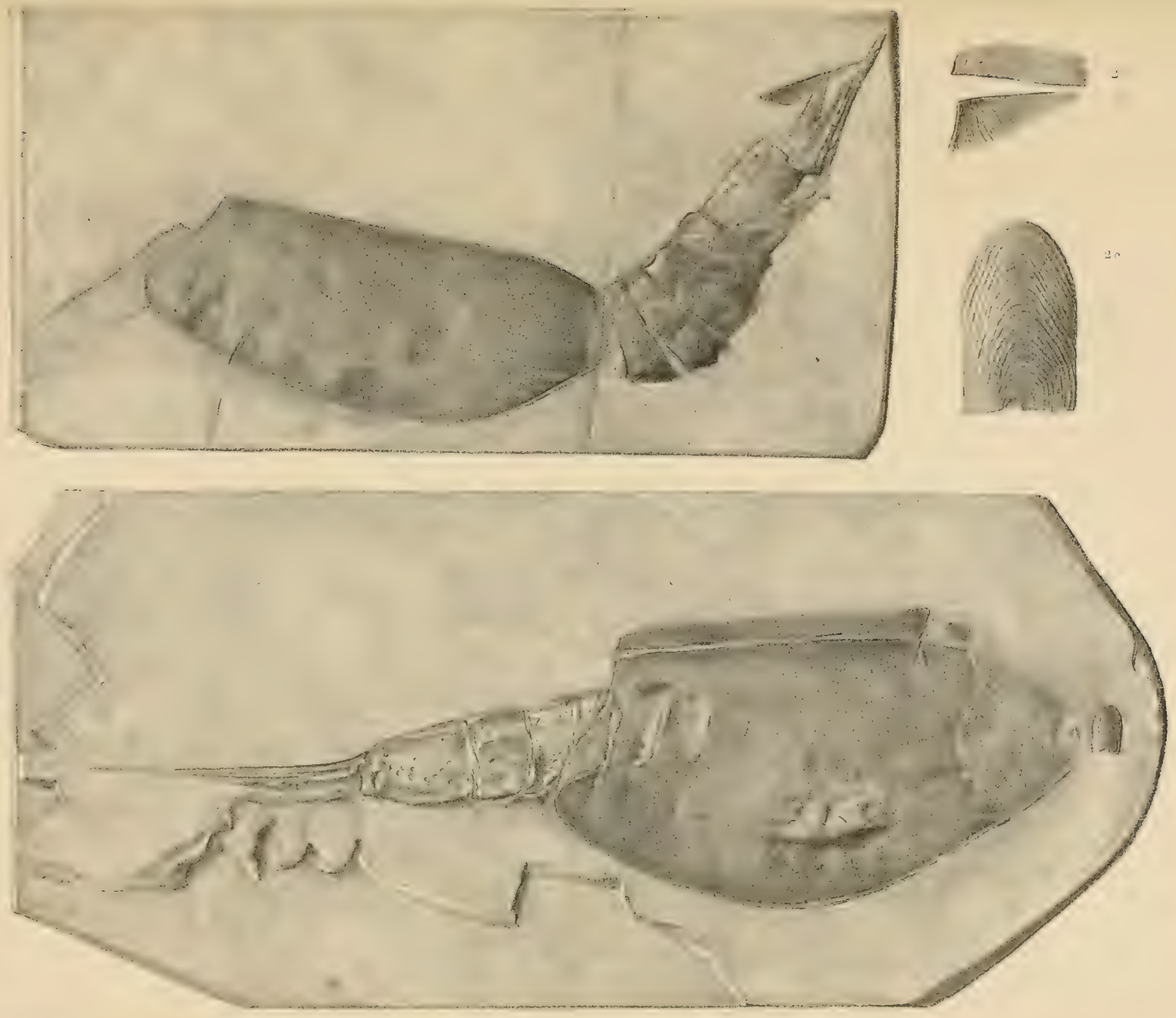
BRITISH FOSSIL PHYLLOPODA

PLATE XII.

(Figs. 1 and 2 *a* are of the natural size; figs. 2 *b* and 2 *c* are magnified.)

Figs. 1. *Ceratiocaris papilio*, Salter. Carapace, showing the right valve, with the abdomen and appendages shifted from behind to the front end, and turned upside down. British Mus. (Page 37.)

Figs. 2 *a*, 2 *b*, 2 *c*. *C. stygia*, Salter. A rather narrow example, perhaps a variety, or modified by pressure. 2 *a*, carapace with right valve outwards, and the abdomen and caudal appendages in place (a broken *rostrum* lies in front of the carapace); 2 *b*, the striæ converging at the postero-dorsal angles, enlarged 3 diam.; 2 *c*, the portion of *rostrum*, enlarged 4 diam. British Mus. (Page 42.)



h Fossil lopoda.

PLATE XIII.

(See pages 74—79.)

Fig.				
1.	*Hymenocaris*	*vermicauda*,	Salter.	Carapace and abdomen. Borth, Portmadoc. Cambridge Museum.
2.	—	—	—	Carapace and abdomen. Borth, Portmadoc. British Museum.
3.	—	—	—	Part of carapace and abdomen. Borth, Portmadoc. British Museum.
4.	—	—	—	Carapace and abdomen separate. Borth, Portmadoc. Cambridge Museum.
5.	—	—	—	Carapace and abdomen. Borth, Portmadoc. Cambridge Museum.
6.	—	—	—	Carapace. Borth, Portmadoc. Cambridge Museum.
7.	—	—	—	Abdomen. Cae'n-y-coed, near Maentwrog. Cambridge Museum.
8.	—	—	—	Abdomen. Portmadoc. Mus. Pract. Geol.
9.	—	—	—	Telson and cercopods. Magnified $2\frac{1}{2}$ diam. Moel-y-gest, Tremadoc. Mus. Pract. Geol.
10.	—	—	—	Abdomen. Gareg-felen. Owens College.
11.	—	—	—	Abdomen. Gareg-felen. Owens College.
12.	—	—	—	Carapace and abdomen. Borth, Portmadoc. Cambridge Museum.
13.	—	—	—	Carapace. Portmadoc. Mus. Pract. Geol.
14.	—	—	—	Abdomen. Borth, Portmadoc. British Museum.

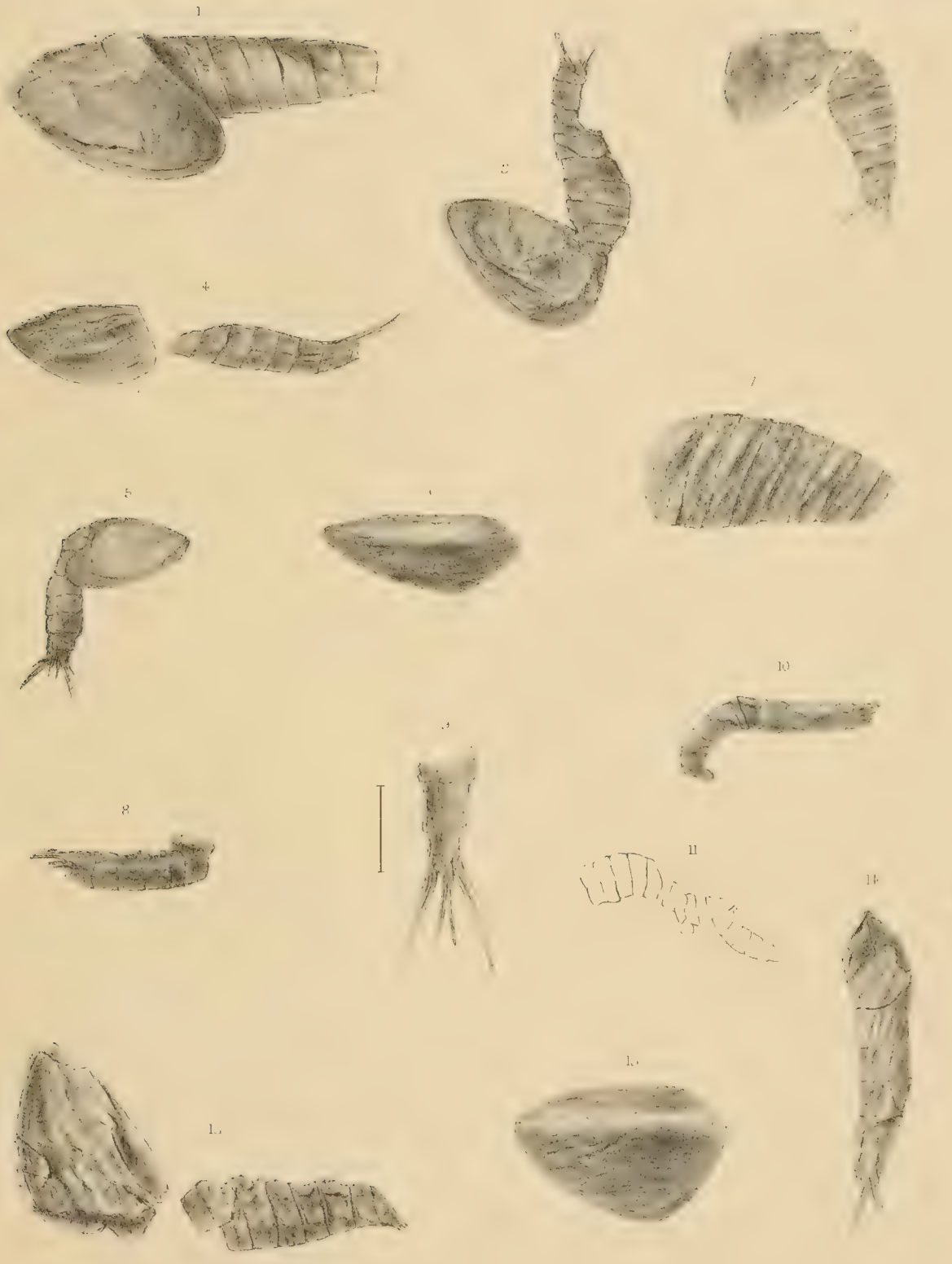


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PLATE XIV.

Fig.

1. *Lingulocaris siliquiformis*, Jones. Left valve. Garth Hill, Portmadoc. British Museum (Page 81.)
2. — — — Left valve. Bwlch-y-gaseg, near Cynwyd. British Museum. (Page 82.)
3. — *Salteriana*, Jones and Woodward. Left valve. Portmadoc. British Museum. (Page 82.)
4. — *lingulæcomes* (?), Salter. Dorsal aspect. Near Builth. Museum of Practical Geology. (Page 81.)
5. — sp. Angers, France. M. Lebesconte's Collection. *a*, right valve; *b*, vertical section. (Page 83.)
6. *Saccocaris major*, Salter. Left valve. Cae'n-y-coed, near Maentwrog. Cambridge Museum. (Page 84.)
7. — *minor*, Jones and Woodward. Left valve and body-rings. (Page 86.)
8. — — — Left valve.
9. — — — Three left valves, one with some body-rings. Arenig. Cambridge Museum. (Page 85.)
10. — — (?) — Part of left valve. Wern, Portmadoc. Cambridge Museum. (Page 88.)
11. *Carycaris Wrightii*, Salter. Skiddaw. Museum of Practical Geology. (Page 89.)
12. — — — Skiddaw. Museum of Practical Geology. (Page 90.)
13. — — — Skiddaw. British Museum. (Page 90.)
14. — — — — — (Page 90.)
15. — — — — Cambridge Museum. (Page 90.)
16. — *Marrii*, Hicks. — Mus. Pract. Geol. (Page 92.)
17. — — — — British Museum. (Page 92.)
18. — — — — Cambridge Museum. (Page 92.)

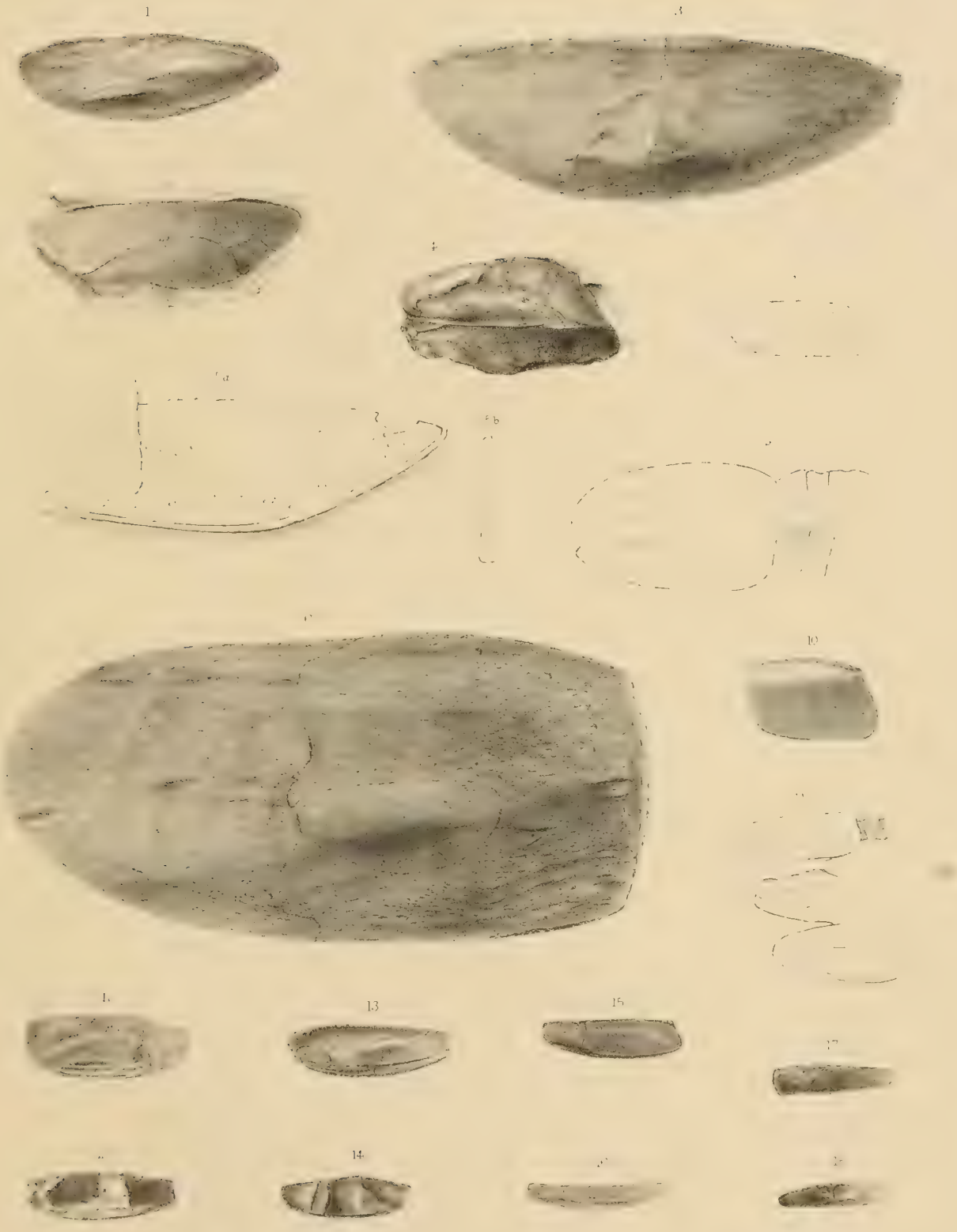

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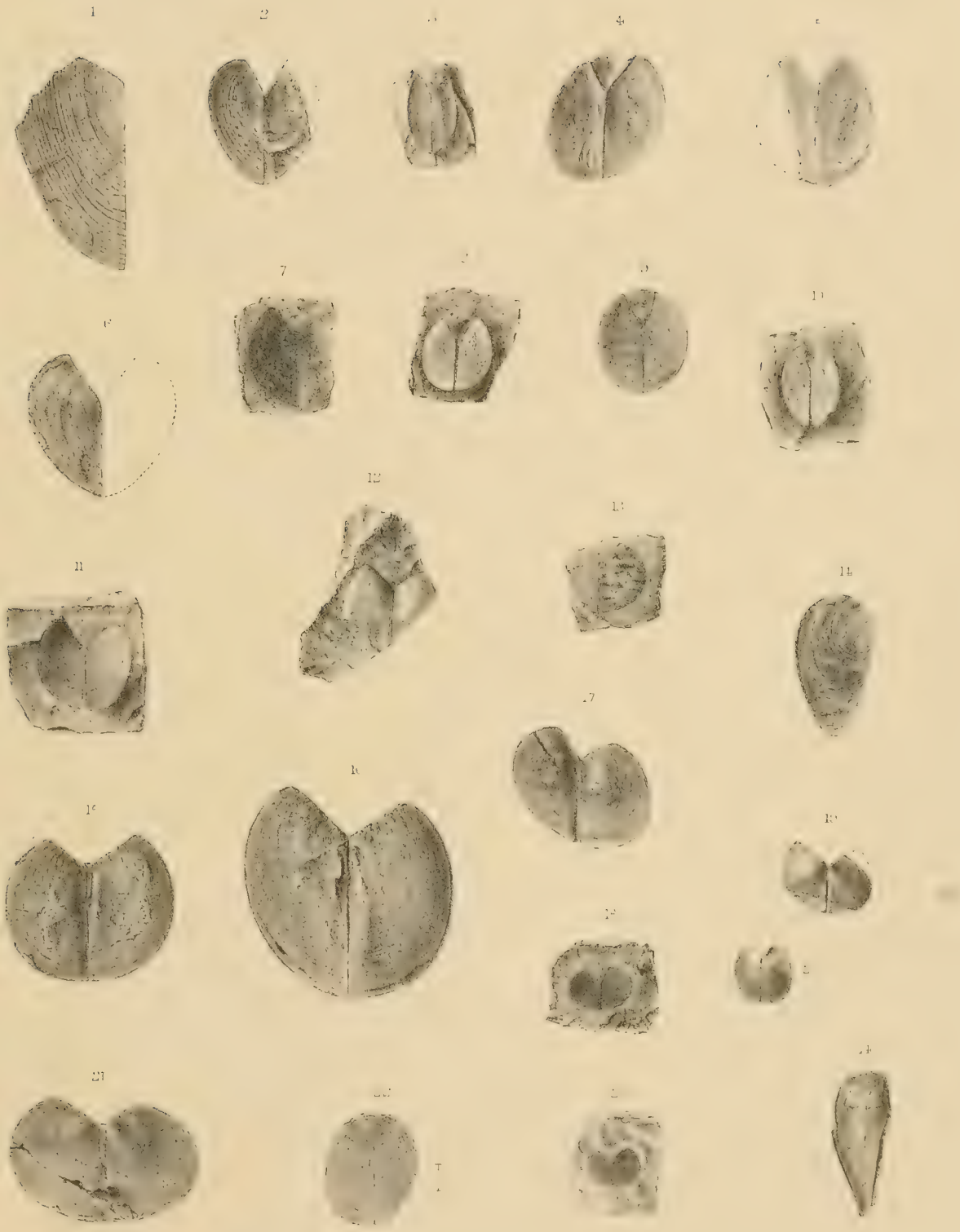
PLATE XV.

(All figured of the natural size except fig. 22.)

Fig.

1. *Aptychopsis Barrandeana*, sp. nov. Left valve. Mus. Geol. Surv. Scotland. (P. 101.)
2. — *cordiformis*, sp. nov. Two valves. Woodwardian Mus. (P. 103.)
3. — *Lapworthi*, H. W. Two valves, crushed. Woodwardian Museum. (P. 106.)
4. — *ovata*, sp. nov. Carapace, squeezed obliquely. Mus. Geol. Surv. Scotland. (P. 108.)
5. — — — Two valves, Mus. Geol. Surv. Scotl. (P. 109.)
6. — *lata*, sp. nov. Left valve. Mus. Geol. Surv. Scotland. (P. 104.)
7. — *Lapworthi*, H. W. Left valve. British Museum. (P. 107.)
8. — — — Two valves. British Museum. (P. 108.)
9. — — — Carapace. British Museum. (P. 108.)
10. — — — Two valves. Mus. Geol. Surv. Scotl. (P. 107.)
11. — *glabra*, H. W. Two valves, squeezed obliquely. British Museum. (P. 105.)
12. — *Wilsoni* (?), H. W. Two valves, imperfect. Mus. Geol. Surv. Scotland. (P. 106.)
13. — *angulata* (?) (Baily). Right valve. Mus. Geol. Surv. Scotland. (P. 110.)
14. — *Barrandeana*, sp. nov., var. *brevior*, nov. Left valve, rounded at ends. [This should have been set straight up.] British Museum. (P. 102.)
15. — *Wilsoni*, H. W. Two valves. Mus. Geol. Surv. Scotl. (P. 106.)
16. — — — Two valves, squeezed obliquely. British Museum. (P. 106.)
17. — *angulata* (?) (Baily). Two valves, squeezed obliquely. Woodwardian Museum. (P. 111.)
18. — *oblata*, sp. nov. Two valves (small). Mus. Geol. Surv. Scotland. (P. 111.)
19. — *angulata* (Baily). Two valves, slightly oblique. Mus. Geol. Surv. Ireland. (P. 110.)
20. — *subquadrata*, sp. nov. Two valves, slightly squeezed. Mus. Geol. Surv. Ireland. (P. 109.)
21. — *oblata*, sp. nov. Two valves. Mus. Geol. Surv. Scotl. (P. 111.)
22. — *Lapworthi*, H. W. Magnified $2\frac{1}{2}$ diameters. Carapace (very small), valves slightly displaced. British Museum. (P. 108.)
23. — *oblata*, sp. nov. Two valves (small). British Museum. (P. 112.)
24. *Pinnocaris Lapworthi*, R. Etheridge, jun. Left-hand moiety of a carapace. Kendal. British Mus. (P. 118.)



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BRITISH FOSSIL PHYLLOPODA

PLATE XVI.

(All the figures are of natural size except figs. 16 *b*, 22 *b*, and 24 *b*, which are × 40.)

Fig.

1. *Peltocaris aptychoides*, Salter. British Museum. (Page 113.)
2. — — — British Museum. (Page 114.)
3. — — — Distorted. Mus. Pract. Geol. (Page 114.)
4. — *anatina*, Salter. Mus. Pract. Geol. (Page 114.)
5. — — — Narrowed by pressure. Cambridge Museum. (Page 115.)
6. — — — Perfect. British Museum. (Page 115.)
7. — — — Mus. Geol. Surv. Scotland. (Page 115.)
8. — — — Coll. D. J. Brown. (Page 115.)
9. — (*aptychoides*, Salter.) Young. Coll. D. J. Brown. (Page 114.)
10. — *patula*, sp. nov. British Museum. (Page 116.)
11. — — — Widened by pressure. Coll. J. E. Marr. Cambridge Museum. (Page 116.)
12. *Discinocaris Browniana*, H. Woodward. Damaged. British Museum. (Page 119.)
13. — — — Squeezed. Mus. Geol. Surv. Scotland. (Page 120.)
14. — — — Squeezed. Mus. Geol. Surv. Scotland. (Page 120.)
15. — — — Widened by pressure. Coll. J. Dairon. (Page 120.)
16. — — — *a*, convex cast, widened by pressure; *b*, interstitial ornament, enlarged 40 diam. Mus. Geol. Surv. Scotland. (Page 121.)
17. — — — Much widened by pressure. Cambridge Museum. (Page 121.)
18. — — — Narrowed by pressure. Cambridge Museum. (Page 121.)
19. — — — Narrowed and flattened by pressure. Cambridge Museum. (Page 121.)
20. — *ovalis*, sp. nov. Coll. D. J. Brown. (Page 121.)
21. — *Browniana*, H. Woodward. Slightly distorted; obscured at the notch. Coll. Lapworth. (Page 121.)
22. — — — *a*, convex cast, widened; *b*, interstitial ornament, enlarged 40 diam. Coll. D. J. Brown. (Page 121.)
23. — — — Distorted. Coll. D. J. Brown. (Page 121.)
24. — *undulata*, sp. nov. *a*, convex cast; *b*, interstitial ornament, enlarged 40 diam. Coll. D. J. Brown. (Page 122.)

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PLATE XVII.

Fig.

1. *Discinocaris gigas*, H. Woodward. Left-hand lower corner of a test. British Museum. (Page 122.)
2. — — — Crushed portion of a test. Cambridge Museum. (Page 123.)
3. — — — Sketch of a large specimen by the late Mr. James Dairon. (The dotted outline has been added to show the more probable form of the shield. The lateral margins in Mr. Dairon's figure are evidently artificial, and not the true margins; nor does it show the real antero-lateral angles. Figs. 1 and 2 indicate the true shape of the postero-lateral angles, and the way in which the lines of growth die out at the margins.) (Page 123.)
4. — (?). Fragment. British Museum. (Page 123.)
5. — (?). Some imperfect body-rings, flattened. British Museum. (Page 123.)
6. *Aptychopsis Salteri*, H. Woodward. Right-hand valve. British Museum. (Page 109.)
7. *Peltocaris Carruthersii*, sp. nov. Carapace. Copied from the 'Quart. Journ. Geol. Soc.,' vol. xxii, pl. 25, fig. 6. (Page 116.)
8. Tail-piece. British Museum. (Page 124.)
9, 10, 11, 12. Tail-pieces. Cambridge Museum. (Page 124.)

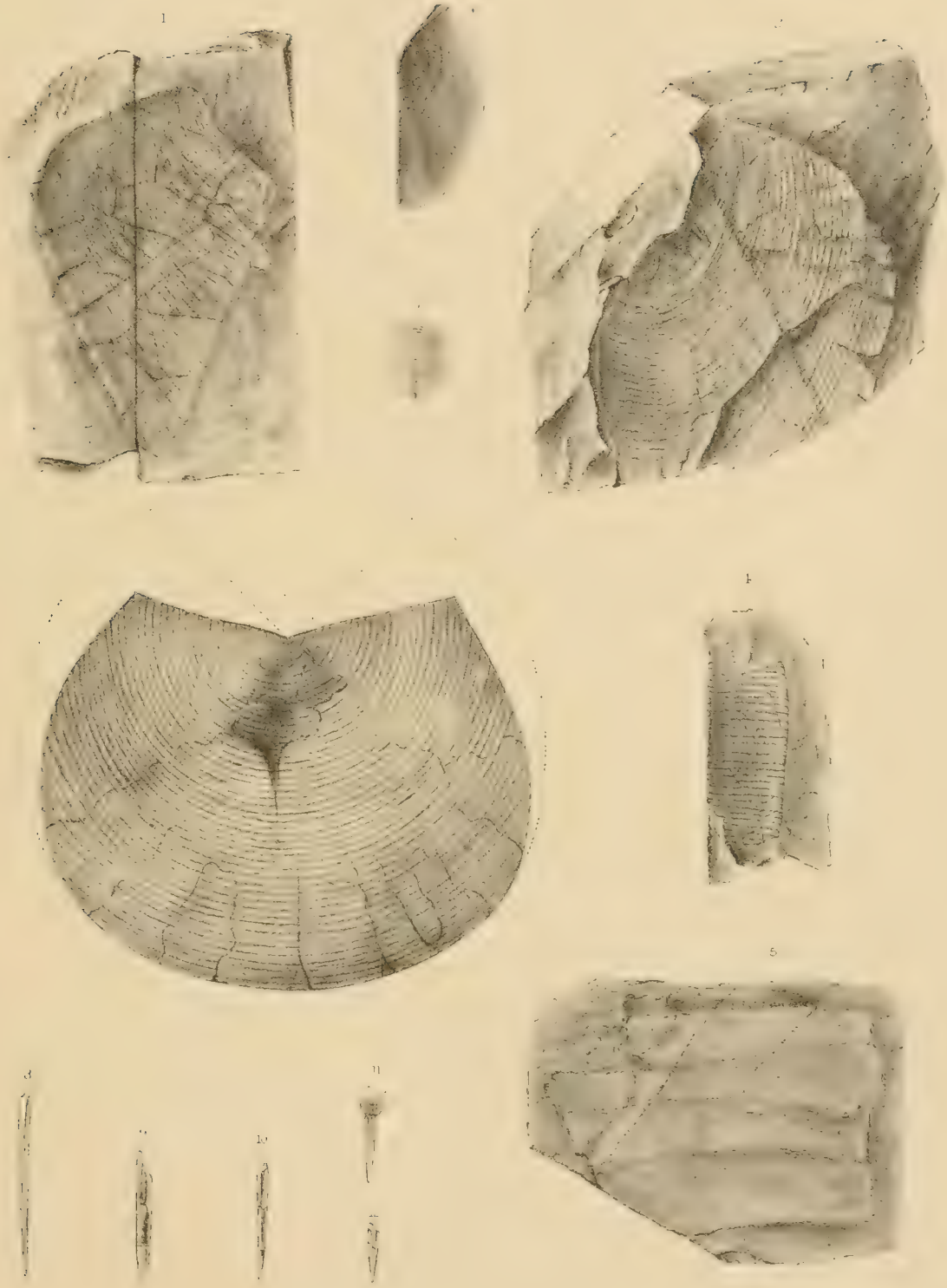

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PLATE XVIII.

Fig. 1 *a*.—*Dithyrocaris glabra*, H. Woodward and R. Etheridge, jun. Left moiety or valve. Mus. Geol. Survey Scotland, 4368, F $\frac{2\,2}{1\,1}$, No. 11 (= 'Geol. Mag.,' 1874, pl. v, fig. 4). (Page 136.)

Fig. 1 *b*.—The same. Part of the surface, with and without the outermost film. × 40.

Fig. 2.—*D. glabra*, W. & E. Right valve. M. G. S. Sc., 4078, F $\frac{2\,2}{1\,1}$, No. 12 (= 'Geol. Mag.,' 1874, pl. v, fig. 5). (Page 137.)

Fig. 3 *a*.—*D. ovalis*, W. & E. Carapace, crushed and open. M. G. S. Sc., F $\frac{2\,2}{4}$, No. 4 (= 'Geol. Mag.,' 1874, pl. v, fig. 1). (Page 140.)

Fig. 3 *b*.—The same. Part of the surface. × 40.

Fig. 4.—*D. granulata*, W. & E. Left valve. M. G. S. Sc., F $\frac{2\,2}{6}$, No. 6; also Pl. XX, fig. 2, magnified (= 'Geol. Mag.,' 1874, pl. v, fig. 2). (Page 142.)

Fig. 5 *a*.—*D. granulata*, W. & E. Left valve. M. G. S. Sc., 4076, F $\frac{2\,2}{1\,1}$, No. 13 (= 'Geol. Mag.,' 1874, pl. v, fig. 3). (Page 144.)

Fig. 5 *b*.—The same. Antero-dorsal region. × $3\frac{1}{2}$.

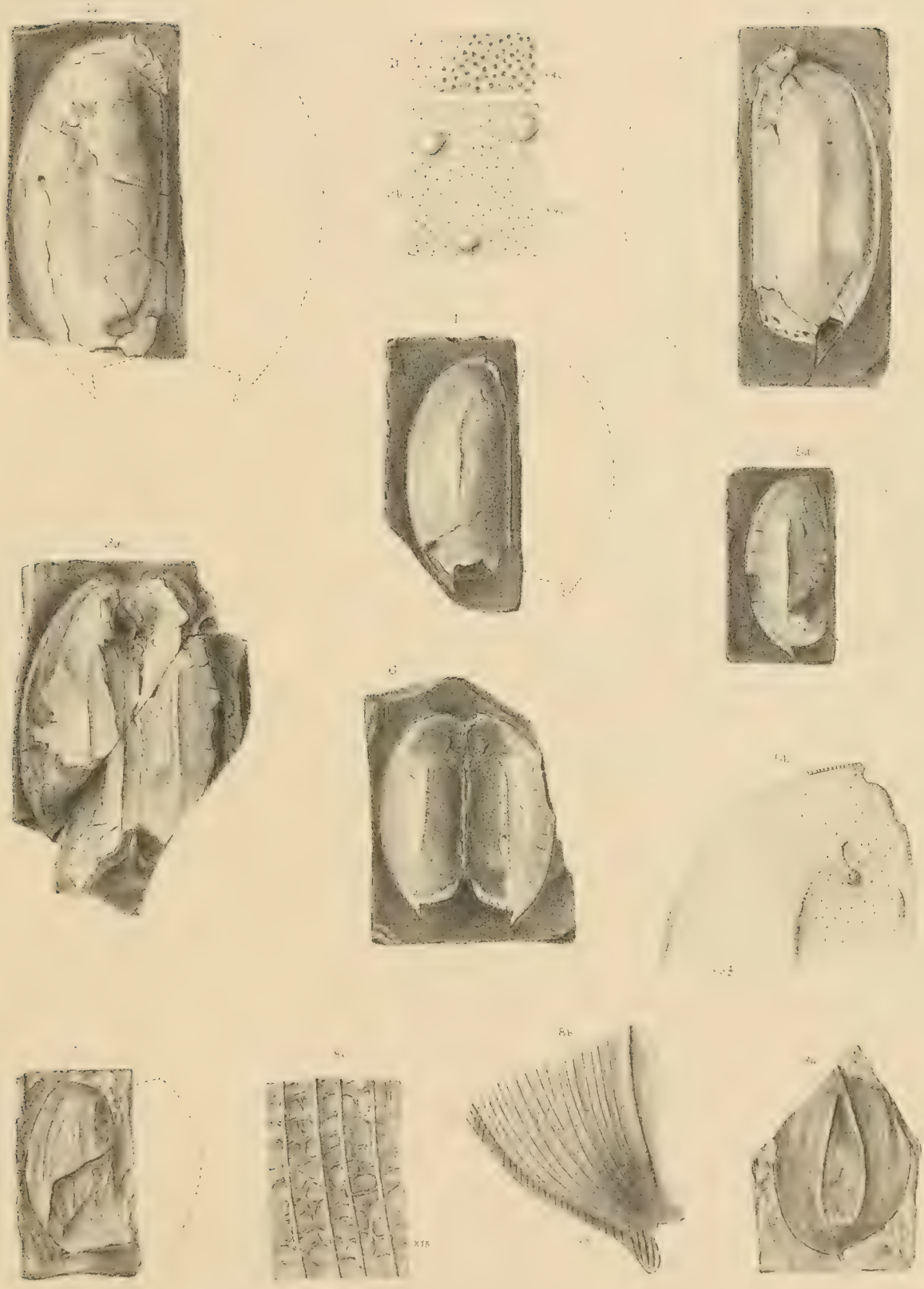
Fig. 6.—*D. granulata*, W. & E. Carapace. Brit. Mus., 59541, No. 9; also Pl. XX, fig. 1, magnified. (Page 144.)

Fig. 7.—*Calyptocaris striata*, Woodward, sp. M. G. S. Sc., M 576 *a*, F $\frac{1\,2}{9\,6}$, No. 15 (= 'Geol. Mag.,' 1874, pl. v, fig. 6). Two valves pressed together, showing the left imperfect.

Fig. 8 *a*.—*Dithyrocaris Belli*, Woodward. Two valves overlapping, imperfect. B. M., No. 25 (= 'Geol. Mag.,' 1871, pl. iii, fig. 5). (Page 176.)

Fig. 8 *b*.—The same. Postero-ventral region of the left valve. × 5.

Fig. 8 *c*.—The same. Part of surface. × 15.



T.R.J. direxit

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BRITISH FOSSIL PHYLLOPODA.

PLATE XIX.

(All the figures of the natural size except Fig. 6 *b*.)

Fig. 1.—*Dithyrocaris glabra*, H. Woodward and R. Etheridge, jun. Left valve. Brit. Mus., 59541, No. 1. (Page 138.)

Fig. 2.—*D. glabra*, W. & E. Two displaced and partly overlapping valves. Mus. Sci. and Art, Edinburgh, 1883, 23, 5, No. 1. (Page 138.)

Fig. 3.—*D. glabra*, W. & E. Right valve and tail. M. Sc. A. Edin., 1883, 23, 5, No. 4. (Page 138.)

Fig. 4.—*D. glabra*, W. & E. Crushed carapace and tail. B. M., 59541, No. 28. (Page 139.)

Fig. 5.—*D. granulata*, W. & E. Right valve, imperfect. M. Sc. A. Edinb., Coutts, 1887, $\frac{25}{15}$, No. 9. (Page 145.)

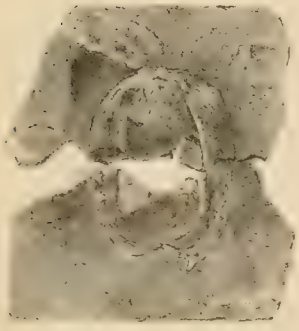
Fig. 6 *a*.—*D. granulata*, W. & E. Carapace, somewhat crushed and imperfect. B. M., 59541, No. 10; also Pl. XX, fig. 3, magnified. (Page 144.)

Fig. 6 *b*.—The same. Part of the surface. × 20.

Fig. 7.—*D. testudinea*, Scouler. Carapace crushed and imperfect. B. M., 59541, No. 15. See also Pl. XXII, fig. 3, cephalic part magnified. (Page 147.)

Fig. 8.—*D. testudinea*, Scouler. Two valves crushed and displaced. B. M., I, 109, No. 21. (Page 147.)

Fig. 9.—*D. testudinea*, Scouler. Two valves overlapping. Museum of Practical Geology, 6268, $\frac{36}{10}$. (Page 148.)



BRITISH FOSSIL PHYLLOPODA

PLATE XX.

Fig. 1 *a*.—*Dithyrocaris granulata*, W. & E. Carapace flattened, open. × $2\frac{1}{2}$. B. M., 59541, No. 9; also Pl. XVIII, fig. 6. (Page 144.)

Fig. 1 *b*.—The same. Two *cephalic* and one *nuchal* ridge. × 5.

Fig. 2 *a*.—*D. granulata*, W. & E. Left valve. × $2\frac{1}{2}$. M. G. S. Sc., F $\frac{22}{6}$, No. 6; also Pl. XVIII, fig. 4. (Page 142.)

Fig. 2 *b*.—The same. Part of surface, including the dorsal ridge. × 14.

Fig. 2 *c*.—The same. Outline of the ridge. × 14.

Fig. 2 *d*.—The same. Part of the surface. × 40.

Fig. 3 *a*.—*D. granulata*, W. & E. Carapace, somewhat crushed. × $2\frac{1}{2}$. B. M., 59541, No. 10; also Pl. XIX, fig. 6. (Page 144.)

Fig. 3 *b*.—The same. Outline of the elevation of the carapace. × $2\frac{1}{2}$.

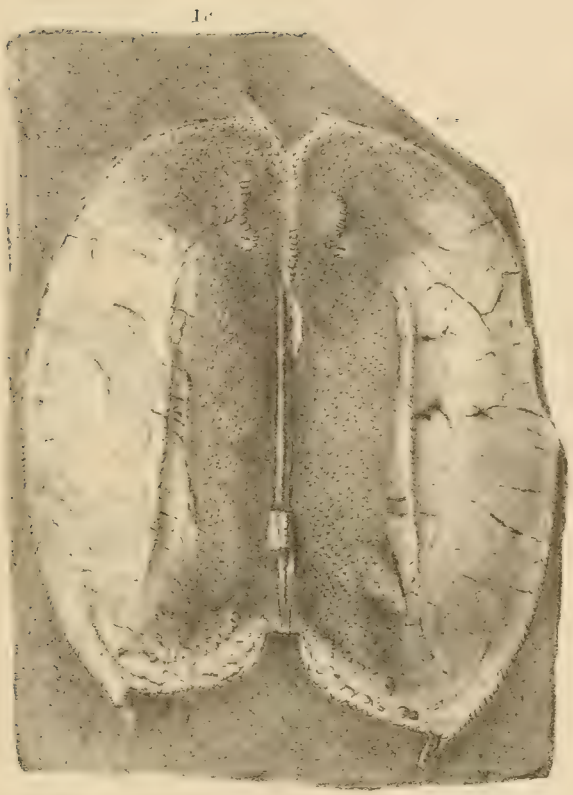
Fig. 3 *c*.—The same. One of the cephalic ridges. × 5.

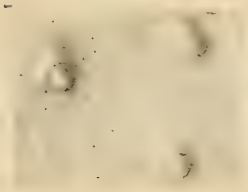
Fig. 3 *d*.—The same. View of the broken end of the dorsal ridge. × 10.

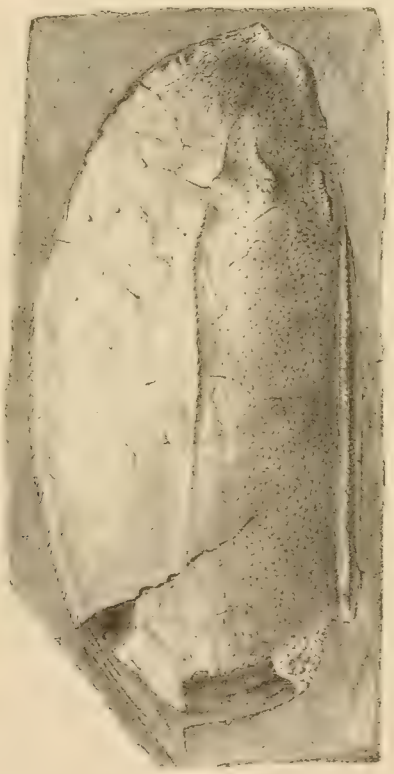
Fig. 3 *e*.—The same. Part of the surface. × 40.

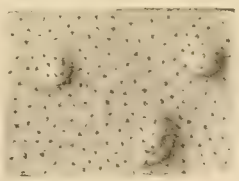
Fig. 3 *f*.—The same. Outline of the elevation of the dorsal ridge. × 15.

Fig. 3 *g*.—The same. Part of the dorsal ridge. × 15.









BRITISH FOSSIL PHYLLOPODA

PLATE XXI.

(All of the natural size except Figs. 11 *d*, 11 *e*, and 11 *f*.)

Fig. 1.—*Dithyrocaris testudinea*, Scouler. Left valve. B. M., 59541, No. 17. (Page 148.)

Fig. 2.—*D. testudinea*, Scouler. Inperfect carapace. B. M., 59541, No. 18. (Page 148.)

Fig. 3.—*D. testudinea*, Scouler. Right valve. M. Sc. A. Edin., Coutts, 1887, $\frac{25}{15}$, No. 13; also Pl. XXXI, fig. 2. (Page 149.)

Fig. 4.—*D. testudinea*, Scouler. Two displaced valves and tail. M. Sc. A. Edin., Coutts, 1887, $\frac{25}{15}$, No. 11. (Page 149.)

Fig. 5.—*D. testudinea*, Scouler. Abdominal segments and tail. B. M., 59541, No. 27; also Pl. XXXI, fig. 4. (Page 150.)

Fig. 6.—*D. testudinea*, Scouler. Right valve. M. Sc. A. Edin., Coutts, 1887, $\frac{25}{15}$, No. 12; also Pl. XXXI, fig. 3. (Page 150.)

Fig. 7 *a*.—*D. Scouleri* (*?*), M'Coy. Left valve.
Fig. 7 *b*.—*D. Scouleri* (*?*), M'Coy. Counterpart of fig. 7 *a*. } M. G. S. Sc., F $\frac{xx}{2}$ (*bis*), No. 17. (Page 155.)

Fig. 8.—*Chænocaris tenuistriata*, M'Coy, sp. Left valve. B. M., 32938, No. 23. (Visé.)

Fig. 9.—*Chænocaris tenuistriata*, M'Coy. Left valve. B. M., 44987, No. 24. (Settle.)

Fig. 10.—*Dithyrocaris Scouleri* (*?*), M'Coy. Caudal extremity. B. M., 59541, No. 22. (Page 155.)

Fig. 11 *a*.—*Chænocaris tenuistriata*, M'Coy, sp. Right valve. Mus. Cambridge. (Settle.)

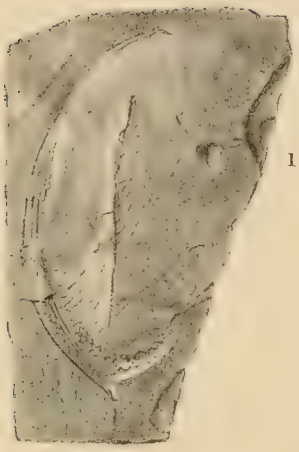
Fig. 11 *b*.—The same. Edge view.

Fig. 11 *c*.—The same. End view.

Fig. 11 *d*.—The same. Part of surface at the ventral margin. × 20.

Fig. 11 *e*.—The same. Part of surface at the mesolateral ridge. × 20.

Fig. 11 *f*.—The same. Part of surface near one end of the valve. × 20.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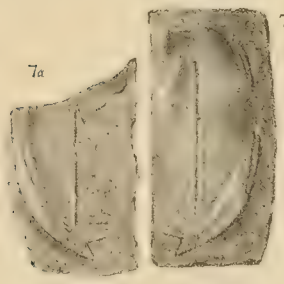
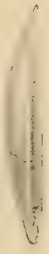
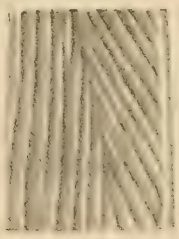
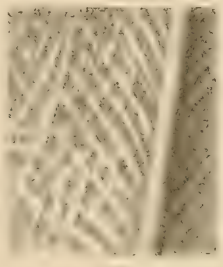

7a 7b

11c

11a


11b


11d


11e

11f

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BRITISH FOSSIL PHYLLOPODA.

PLATE XXII.

Fig. 1 *a*.—*Chænocaris Youngii*, sp. nov. Carapace, showing the left valve. J. Young Coll. (Robroystone.) × 7.

Fig. 1 *b*.—The same. Carapace, showing the right valve. × 7.

Fig. 1 *c*.—The same. Carapace, end view. × 7.

Fig. 1 *d*.—The same. Carapace, back view. × 7.

Fig. 1 *e*.—The same. Part of surface at the mesolateral ridge. × 30.

Fig. 2.—*Chænocaris? Richteriana*, sp. nov. One valve, imperfect at the edges. × 5. From Saalfeld.

Fig. 3.—*D. testudinea*, Scouler. Cephalic portion. × 3. B. M., 59541, No. 15; also Pl. XIX, fig. 7. (Page 147.)

Fig. 4.—*D. tricornis*, Scouler. Part of surface of fig. 5, Pl. XXIV. × 30. (Page 174.)

Fig. 5 *a*.—*D. tricornis*, Scouler. Part of right valve. Dunn Coll. C 14. (Redesdale.) (Page 173.)

Fig. 5 *b*.—The same. Part of the dorsal ridge. × 5.

Fig. 5 *c*.—The same. End view of the dorsal ridge. × 5.

Fig. 5 *d*.—The same. Left-hand side of part of the dorsal ridge. × 10.

Fig. 5 *e*.—The same. Part of the surface. × 15.

Fig. 6 *a*.—*D. funiculata*, sp. nov. Right valve. M. G. S. Sc., F $\frac{xx}{7}$, No. 7. (Page 158.)

Fig. 6 *b*.—The same. Part of the postero-ventral region. × 8.

Fig. 6 *c*.—The same. Part of the ventral edge. × 8.

Fig. 6 *d*.—The same. Part of the surface. × 20.

Fig. 7.—*D. Colei*, Portlock. Imperfect left valve of small individual. M. G. Surv. Scot., *m* 4271, F $\frac{xx}{6}$, No. 21. (Page 167.)

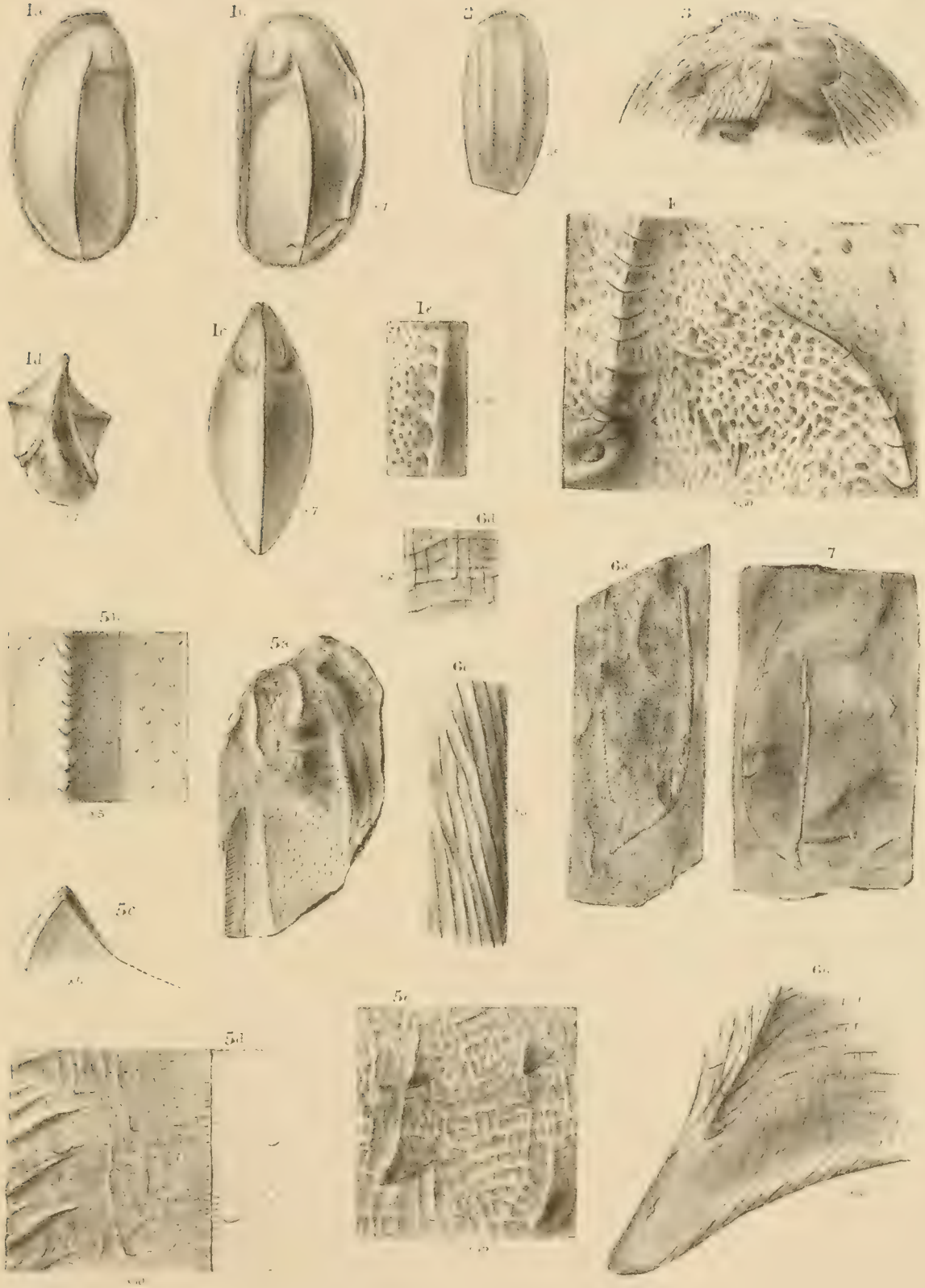

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PLATE XXIII.

(All the figures are of the natural size.)

Fig. 1.—*Dithyrocaris Colei*, Portlock. Right valve nearly perfect, and part of another overlying; also Pl. XXIV, fig. 4. M. P. G., 6262, $\frac{3\,6}{3}$ (= Portlock's pl. xii, fig. 2). (Page 164.)

Fig. 2.—*D. Colei*, Portlock. Tail. M. P. G., 6261, $\frac{3\,6}{7}$ (Portlock's pl. xii, fig. 4).

Fig. 3.—*D. Colei*, Portlock. Tail. M. P. G., 6261, $\frac{3\,6}{7}$ (Portlock's pl. xii, fig. 5).

Fig. 4.—*D. Colei*, Portlock. Tail. M. P. G., 6265, $\frac{3\,6}{6}$ (Portlock's pl. xii, fig. 3 *a*).

Fig. 5.—*D. lateralis*, M'Coy. Tail. M. G. S. Sc., m 4268 *b*, and counterpart, m 42667 *b*, No. 26.

Fig. 6.—*D. lateralis*, M'Coy. Tail. Mus. Cambridge.

Fig. 7.—*D. testudinea* (*?*), Scouler. Tail. B. M., 59541, No. 30. (Page 150.)

Fig. 8.—*D. testudinea*, Scouler. Tail. B. M., Rankin, No. 29. (Page 151.)

Fig. 9.—*D. Dunnii*, sp. nov. Tail. Dunn Coll., $\frac{2\,8}{b}$.

Fig. 10.—*D. Dunnii*, sp. nov. Tail. Dunn Coll., $\frac{2\,8}{1}$.

Fig. 11.—*D. glabra*, W. & E. Two displaced valves and a tail. M. Sc. A. Edinb., 1886, 91, 1, No. 5. (Page 140.)

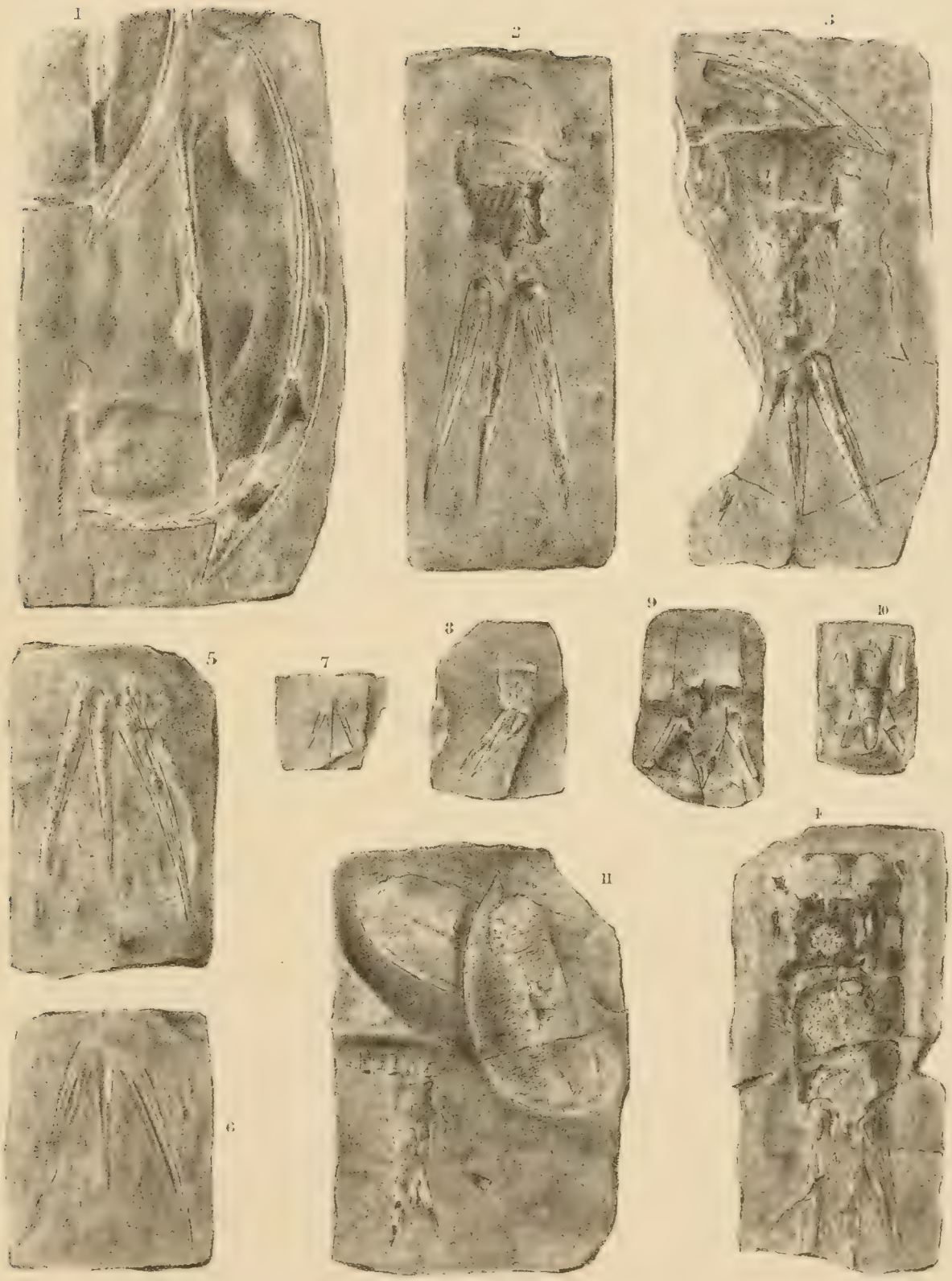
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PLATE XXIV.

(All the figures are of the natural size).

Fig. 1.—*Dithyrocaris tricornis*, Scouler. Carapace and abdominal segments. Mus. Geol. Surv. Scotl., F $\frac{22}{12}$, No. 14. (Page 171.)

Fig. 2.—*D. Colei*, Portlock. Carapace, imperfect. (The type.) Mus. Pract. Geol. 6263, $\frac{36}{8}$. (Page 165.)

Fig. 3.—*D. orbicularis*, Portlock. Carapace, crushed. (The type.) M. P. G., 6266, $\frac{36}{11}$. (Page 168.)

Fig. 4.—*D. Colei*, Portlock. Right moiety or valve. M. P. G., 6262 (part). (Overlapping fig. 1, Pl. XXIII.) (Page 166.)

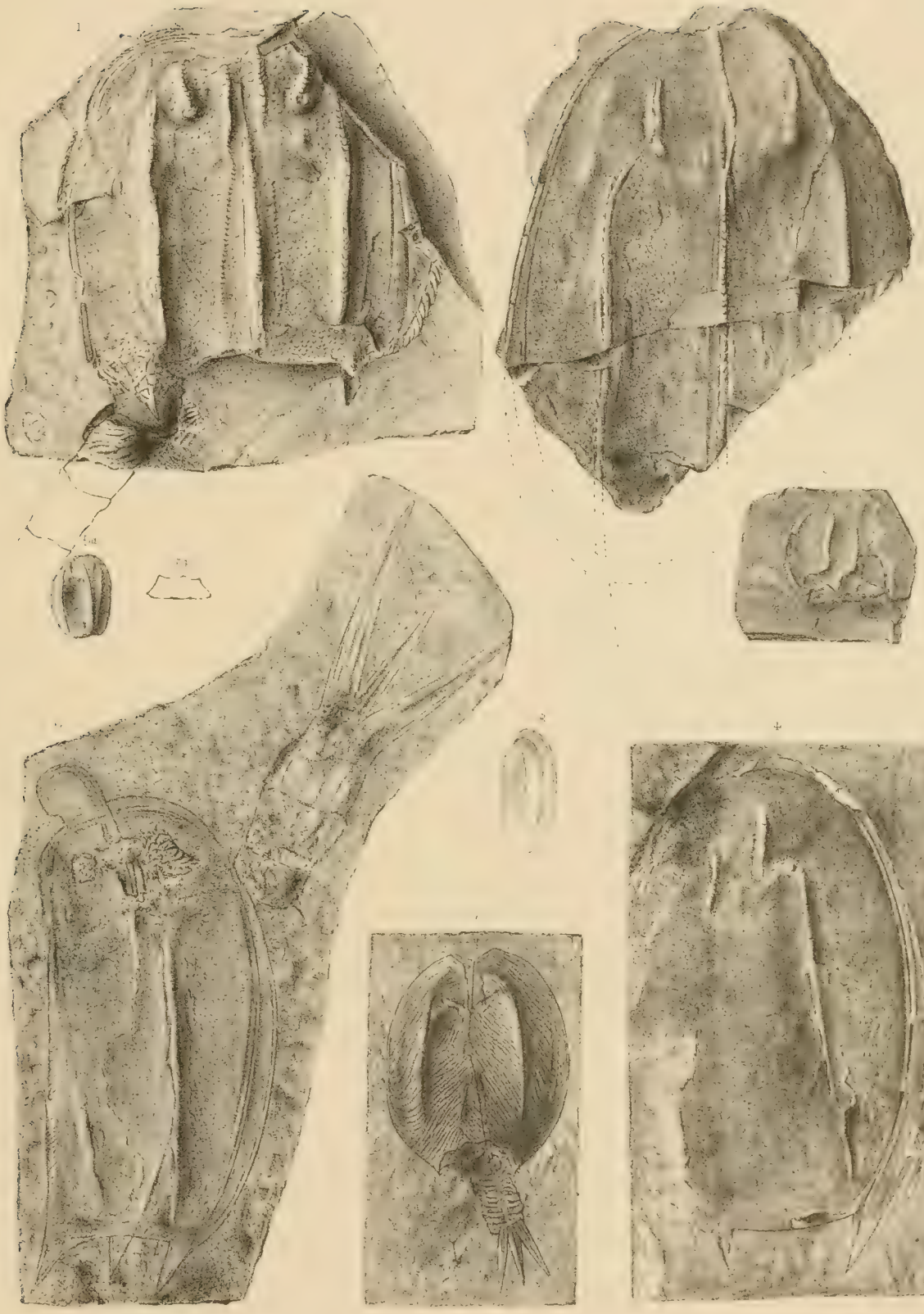
Fig. 5 *a*.—*D. tricornis*, Scouler. Carapace of small individual. M. G. S. Sc., F $\frac{22}{9}$, No. 9. (Page 174.)

Fig. 5 *b*.—The same. End view in outline.

Fig. 6.—*D. tricornis*, Scouler. Folded and compressed carapace and tail. (The type.) Mus. Tech. Coll. Glasgow. (Page 172.)

Fig. 7.—*D. testudinea*, Scouler. Carapace, abdominal segments, and tail. (The type.) Mus. Tech. Coll. Glasgow. (Page 146.)

Fig. 8.—*Chænocaris tenuistriata*, M'Coy, sp. Right valve. (The type.) Copied from M'Coy's 'Carb. Fossils Ireland,' pl. xxiii, fig. 3.



T.R.J. direxit

BRITISH FOSSIL PHYLLOPODA.

PLATE XXV.

Fig. 1.—*Dithyrocaris glabra*, W. & E. Part of the dorsal ridge of one of two valves. × 2½. B. M., 59541, No. 6. (Page 139.)

Fig. 2.—*D. glabra*, W. & E. Part of the dorsal ridge of the left valve. × 2½. B. M., 59541, No. 8. (Page 139.)

Fig. 3 *a*.—*D. insignis*, sp. nov. Part of right valve among displaced fragments of two valves. Mus. Leeds Coll. × 2½. (Page 159.)

Fig. 3 *b*.—The same. Part of the surface. × 10.

Fig. 3 *c*.—The same. Part of the surface. × 50.

Fig. 4 *a*.—Possibly from the same specimen. Part of a dorsal ridge. × 3.

Fig. 4 *b*.—The same. Part of its surface. × 10.

Fig. 4 *c*.—The same. Outline of its elevation. × 10.

Fig. 4 *d*.—The same. Part of its surface. × 10.

Fig. 4 *e*.—The same. Part of its surface. × 50.

Fig. 5 *a*.—Probably from the same specimen. Fragment of a valve. × 10.

Fig. 5 *b*.—The same. Part of its surface. × 50.

Fig. 6 *a*.—*D. Scouleri*, M'Coy. Carapace and tail. Copied from M'Coy's 'Carb. Foss. Ireland,' pl. xxiii, fig. 2. (Page 155.)

Fig. 6 *b*.—The same.
Fig. 6 *c*.—The same. } Parts of the ridges.

Fig. 7.—*D.* sp. (?). From a plaster cast. Griffith Coll. Dublin. (Page 157.)

Fig. 8 *a*.—*Hibbertia orbicularis*, gen. and sp. nov. × 2. (Burdiehouse.)

Fig. 8 *b*.—The left-hand postero-ventral angle. × 5.

Fig. 9 *a*.—*D. Colei* (?) vel *tricornis* (?). A separate dorsal ridge. M. G. S. Sc., F $\frac{xx}{5}$, No. 20. (Page 175.)

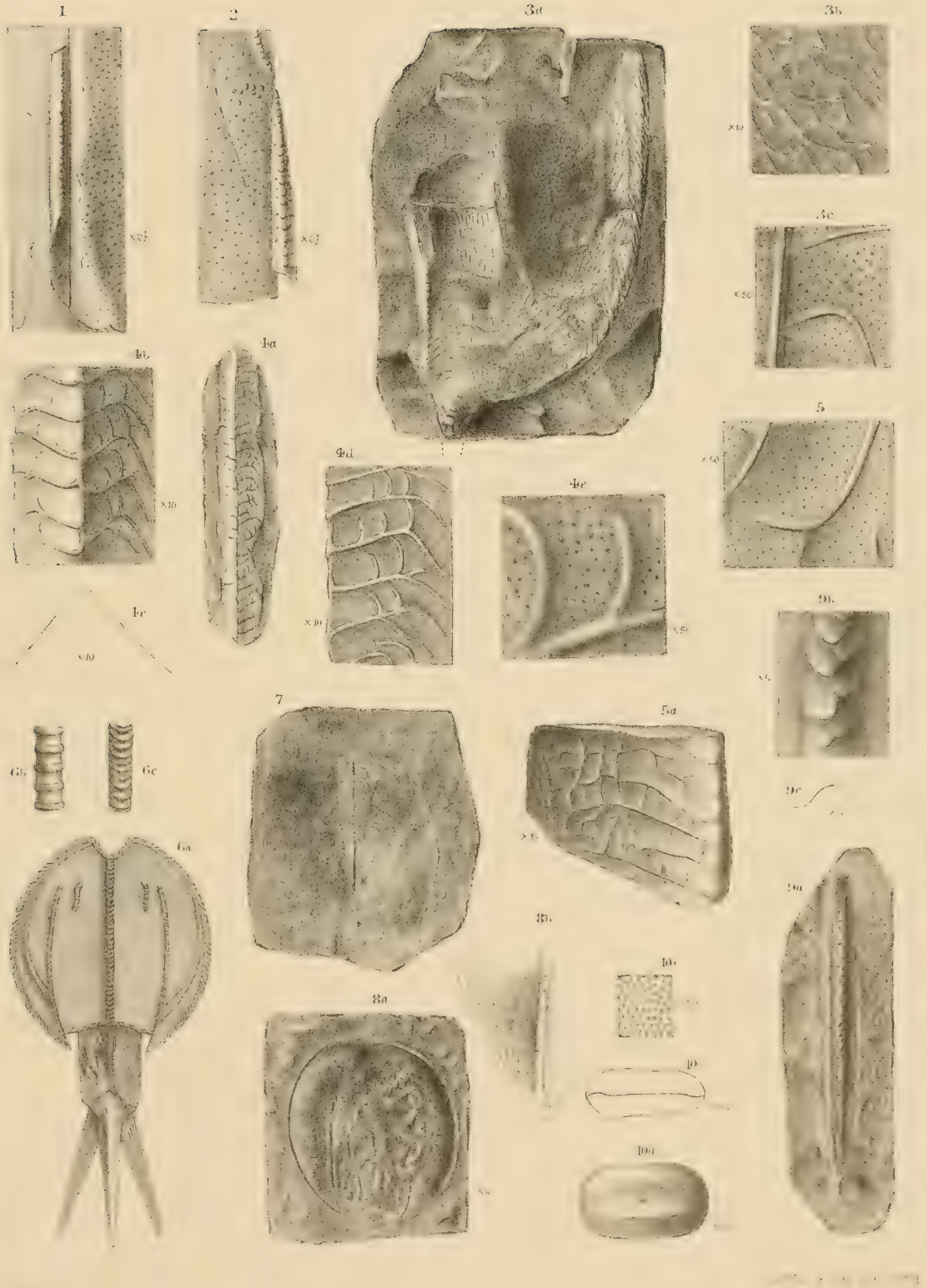
Fig. 9 *b*.—The same. Part of its surface. × 5.

Fig. 9 *c*.—The same. Outline of its elevation. × 5.

Fig. 10 *a*.—*Kirkbya plicata*, J. & K. Carapace, showing the right valve. × 25. On the same specimen with fig. 9. (Page 175.)

Fig. 10 *b*.—The same. Dorsal view. × 25.

Fig. 10 *c*.—The same. Part of the surface. × 50.



BRITISH FOSSIL PHYLLOPODA.

PLATE XXVI.

Illustrating the Masticatory Apparatus or Gastric Teeth of *Dithyrocaris*.

See pp. 194—198.

(Figs. 2—8 of natural size. Figs. 1 and 9—44 magnified twice the natural size.)

Fig.

1. Dextral. Copied from 'Geol. Mag.,' 1865, pl. xi, fig. 3 *b*
2. " " fig. 3
3. " " fig. 3 *a*

Orchard Quarry, Thornliebank, four miles from Glasgow, Renfrewshire.

4. Dextral " " fig. 4
5. " " fig. 4 *a*

Lower Marine series, Campsie.

6. Dextral " " fig. 5
7. " " fig. 5 *a*

Orchard Quarry, Thornliebank.

8. Both Dextral and Sinistral, but not distinct. Copied from 'Geol. Mag.,' 1865, pl. xi, fig. 8. Lickprivick Quarry, two miles south-west of East Kilbride.

9. Sinistral. Museum Geological Survey of Scotland, No. 5, F $\frac{2}{5}$. Lower Limestone Group.
10. Cowden's Quarry, Dunfermline.

11. Sinistral. Museum Geological Survey of Scotland, No. 2, F $\frac{2}{2}$. Lower Limestone Group.
12. Dolly Quarry, Drumford, Dunfermline.

13. Dextral
14. (Base of the tooth ironstone)
15. Dextral
16.

British Museum, No. 32, 59,776. Orchard Quarry, Renfrewshire.

17. Sinistral. British Museum, No. 33, I. 754. Orchard Quarry, Renfrewshire.
18. (Base of tooth ironstone.)

19. Dextral. British Museum, No. 31, 42,513. Coal-measures, Newcastle-on-Tyne.
20. (Base of tooth slightly calcareous.)

21. Dextral
22. Dextral, reversed. (Base of tooth calcareous)
23. Sinistral
24. (Calcareous base)
25. Sinistral
26.

Dunn Collection, marked C. 12. Redesdale.

27. Dextral
28 (?).
29. Sinistral

Neilson Collection, marked L. Orchard Quarry, Renfrewshire.

30. Dextral. Neilson Collection, marked K. East Kilbride.
31. (Calcareous base.)

32. Dextral. Neilson Collection, marked L. Orchard Quarry, Renfrewshire.

33. Sinistral. (Reddish specimen with non-calcareous base of tooth.) Neilson Collection, marked N.
34. Cock-of-Arran Upper Limestone series.

35. Sinistral. Dunn Collection, marked C. 12. Redesdale.
36.

37. Dextral
38.

39. Dextral
40. Dextral
41. Sinistral

Neilson Collection, marked L. Orchard Quarry, Renfrewshire.

42. Sinistral. Yorkshire College Museum, Leeds. Eccup, Yorkshire.

43. Dextral. Neilson Collection, marked M. Encrinital Limestone, Skateraw, Dunbar.

44. Both; sinistral lying on the dextral tooth. Mus. Pract. Geol., 6264. Tyrone or Londonderry.

J. E. Lines del.

West & Sons lith. et imp.

BRITISH FOSSIL PHYLLOPODA.

PLATE XXVII.

Fig. 1 *a*.—*Dithyrocaris insignis*, sp. nov. Postero-ventral portion of a right-hand valve. × 2. Neilson Collection, marked B. East Kilbride.

Fig. 1 *b*.—*Dithyrocaris insignis*, sp. nov. Part of the ornament of the valve. × 10.

Fig. 1 *c*.—*Dithyrocaris insignis*, sp. nov. Part of the ornament of the valve. × 60.

(Page 160.)

Fig. 2 *a*.—*D. tricornis*, Scouler. Natural impression of the postero-ventral portion (with its inturned edge) of the right valve. Nat. size. Mus. Pract. Geol. Counterpart of Plate XXIV, fig. 1. Kirktonholme, East Kilbride.

Fig. 2 *b*.—*D. tricornis*, Scouler. Ornament from the sides of the thin ridge near its junction with the postero-ventral margin. × 30.

Fig. 2 *c*.—Part of the same. × 50.

(Page 172.)

Fig. 3 *a*.—*D. testudinea*, Scouler. An isolated dorsal crest. Nat. size. Neilson Collection, marked H. Kirktonholme, East Kilbride.

Fig. 3 *b*.—*D. testudinea*, Scouler. Part of the ornament. × 15.

(Page 151.)

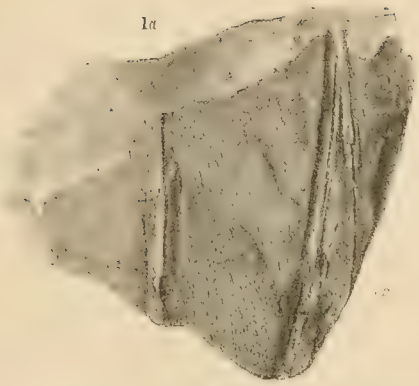
Fig. 4 *a*.—*D. tricornis*, Scouler. A nearly perfect carapace of a small individual. Nat. size. Neilson Coll., marked F. East Kilbride.

Fig. 4 *b*.—*D. tricornis*, Scouler. Side view.
Fig. 4 *c*.—*D. tricornis*, Scouler. Front view.
Fig. 4 *d*.—*D. tricornis*, Scouler. Hind view.
× 3 +.

Fig. 4 *e*.—*D. tricornis*, Scouler. Ornament at the dorsal and juxtadorsal ridges. × 30.

(Page 174.)

Fig. 5.—*D. Colei*, Portlock. A small specimen. Nat. size. Mus. Pract. Geol., 6260. Londonderry. (Page 168.)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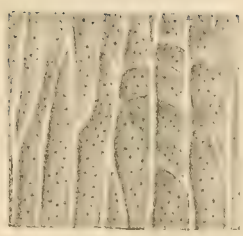
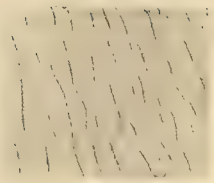

2c

3d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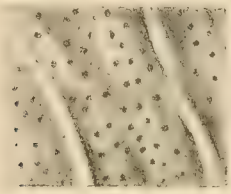
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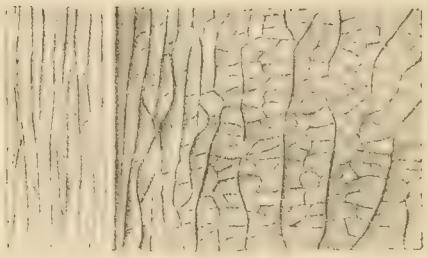
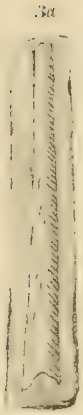
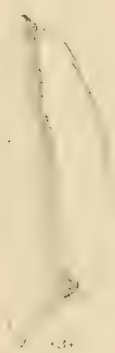

2b


3a

1d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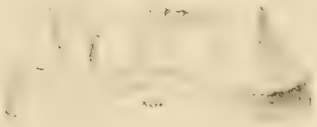
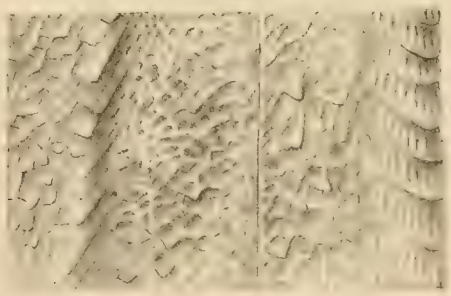

1e

1d

3b


1c

5

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Jno West & Sons lith et imp.

BRITISH FOSSIL PHYLLOPODA.

PLATE XXVIII.

Fig. 1 *a*.—*Dithyrocaris testudinea*, Scouler. A perfect right-hand valve, with its dorsal crest. × $2\frac{1}{2}$. Neilson Collection, marked D. East Kilbride. (Page 151.

Fig. 1 *b*.—Part of the dorsal crest. × 15.

Fig. 2.—*D. testudinea*, Scouler. The hinder portion of a right valve. × $2\frac{1}{2}$. Neilson Collection, marked C. East Kilbride. (Page 151.)

Fig. 3 *a*.—*D. testudinea*, Scouler. Posterior fragment of a left-hand valve. × 3. Neilson Collection, marked E. East Kilbride. (Page 152.)

Fig. 3 *b*.—Ornament of the mesolateral ridge. × 30.

Fig. 4.—*D. testudinea*, Scouler. Left valve, deformed by pressure. × $2\frac{1}{2}$. Mus. Geol. Surv. Scotl., F $\frac{2}{10}$, No. 10. Lickprivick, two miles south-west of East Kilbride. (Page 152.)

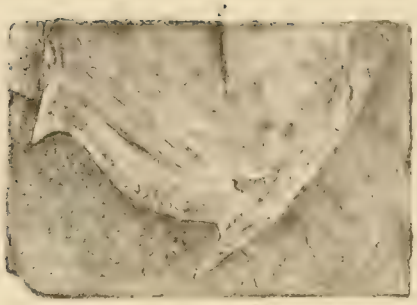
Fig. 5 *a*.—*D. testudinea*, Scouler. Natural impression of the outside of the two valves of an open carapace, together with a part of the inturned ventral edge. Mus. Sc. Art Edin., No. 10. East Kilbride. (Page 152.)

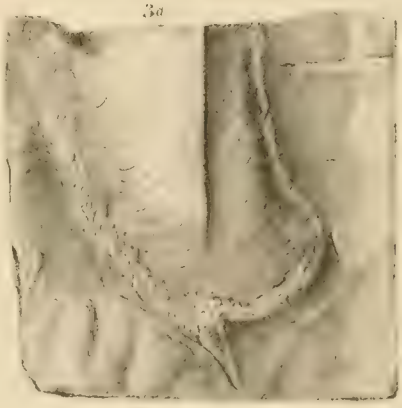
Fig. 5 *b*.—Part of the ornament of the valve as seen in the impression near the ventral margin, and the straight-lined sculpture of the inturned edge. × 10.

Fig. 5 *c*.—Part of the ornament of the valve (imperfect), giving casts of small pits. × 50.

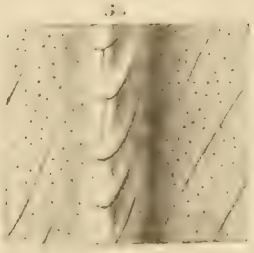
1a

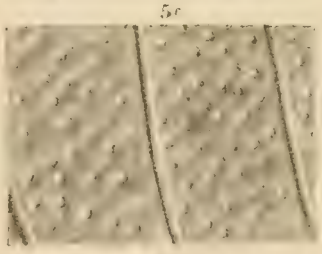
1b




3a

5a


5b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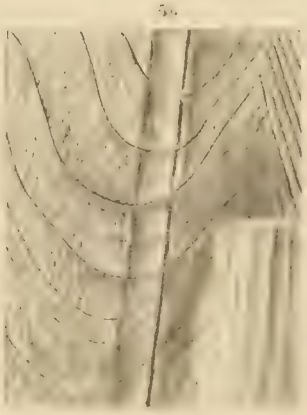
5d

T.R.J. direxit

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PLATE XXIX.

Fig. 1.—*Dithyrocaris Dunnii*, sp. nov. A trifid tail, imperfect. Nat. size. Mus. Geol. Surv., Scotland, F $\frac{xx}{2}$. No. 17. Larriston Burn. (Page 186.)

Fig. 2.—*D. Dunnii*. M. G. S. Sc., F $\frac{xx}{4}$, No. 19. Harebow Hill Quarry, Penton, Cannobie. Part of a caudal trifid. Nat. size. (Page 186.)

Fig. 3 *a*, Fig. 3 *b*, Fig. 3 *c*. *D. Neilsoni*, sp. nov. Caudal appendages. Nat. size. Neilson Collection, marked K. East Kilbride. (Page 187.)

Fig. 4.—*Rhaehura* (*Dithyrocaris?*) *venosa*, Scudder. Copied from 'Proc. Boston Soc. N. H.,' vol. xix, pl. ix, fig. 3. Caudal appendages, ventral aspect. Nat. size. Coal-measures, Illinois. (Page 188.)

Fig. 5 *a*.—*Dithyrocaris carbonaria*, Meek and Worthen. Copied from 'Geol. Surv. Ill.,' vol. v, pl. xxxii, fig. 1 *a*. Caudal appendages, ventral aspect. 1 *a*. Coal-measures, Illinois. Nat. size. (Page 190.)

Fig. 5 *b*.—*D. carbonaria*. Sectional area of thick part of the stylet (part of fig. 1 *a*).

Fig. 6.—*D. carbonaria*. Caudal appendages, dorsal aspect. Copied from M. and W.'s fig. 1 *b*.

Fig. 7.—*D. Kochi*, Ludwig. Copied from 'Palæontogr.,' vol. xi, pl. l, fig. 1 *a*. Devonian, Herborn, Dillthal, Nassau. Caudal appendages. Dorsal aspect. Nat. size. (Page 191.)

Fig. 8.—*D. Kochi*. Copied from Ludwig's fig. 1. Caudal appendage. Ventral aspect. Nat. size. Devonian, Herborn. (Page 191.)

Fig. 9.—*D. breviaculeata*, Ludwig. Copied from 'Palæontogr.,' vol. xi, pl. l, fig. 2. Caudal appendage. Ventral aspect. Devonian, Butzbach, Nassau. (Page 191.)

Fig. 10 *a*.—*D. testudinea*, Scouler. An ultimate abdominal segment. Dorsal aspect. Neilson Collection. J. East Kilbride. × 3.

Fig. 10 *b*.—*D. testudinea*, Scouler. Ventral aspect. × 3.

Fig. 10 *c*.—*D. testudinea*, Scouler. Sectional area. × 3.

Fig. 11 *a*.—*D. testudinea*, Scouler. Ventral aspect. × 3.

Fig. 11 *b*.—*D. testudinea*, Scouler. Ornament. × 100.

Fig. 12 *a*.—*D. testudinea*, Scouler. Dorsal aspect. × 3.

Fig. 12 *b*.—*D. testudinea*, Scouler. Ventral aspect. × 3.

Fig. 12 *c*.—*D. testudinea*, Scouler. Sectional area. × 3.

Fig. 12 *d*.—*D. testudinea*, Scouler. Ornament. × 20.

Fig. 13 *a*.—*D. testudinea*, Scouler. Dorsal aspect. × 3.

Fig. 13 *b*.—*D. testudinea*, Scouler. Ventral aspect. × 3.

Fig. 13 *c*.—*D. testudinea*, Scouler. Sectional area. × 3.

Fig. 14.—*D. testudinea*, Scouler. Diagram of the lines on the outside of an ultimate abdominal segment; the dorsal lines dark and the ventral lines dotted. × 3.

(Page 153.)

Fig. 15 *a*.—*Ptychocaris? Jaschei* (Römer). Copied from 'Palæontogr.,' vol. v, pl. ii, figs. 13 *a*–*c*. Fragment. Nat. size. Devonian, Klosterholz, Hartz.

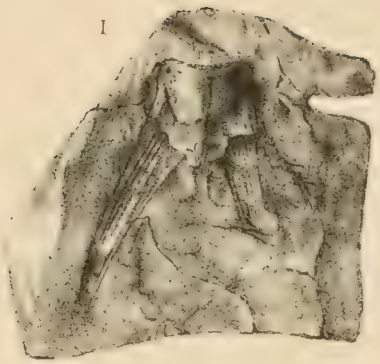
Fig. 15 *b*.—Outline of the sectional area.

Fig. 15 *c*.—Magnified part of the ornament.

Fig. 16 *a*.—Copied from (Kayser) 'Abhandl. Kart. Preuss.,' vol. ii, Heft 4, pl. i, figs. 13, 13 *a*. Fragment. Nat. size.

Fig. 16 *b*.—Sectional area.

(Page 193.)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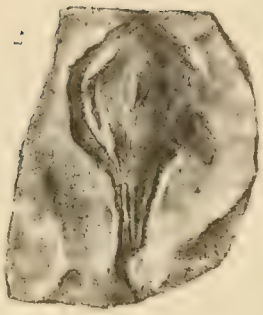
3a


2

3b

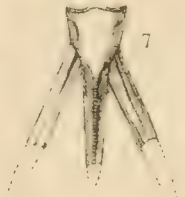
3c

4

5a

5b

6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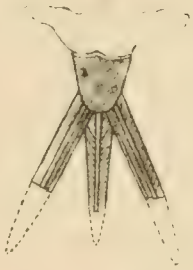
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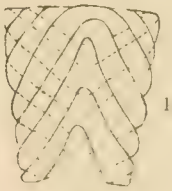
9

15a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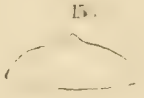
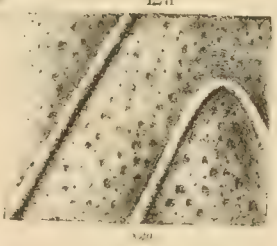

15b

10a


12d

12a

15c

13a

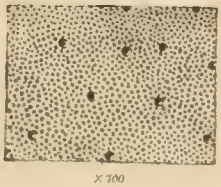
10b

11a

12b

13b

15d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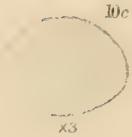

10c

12c

13c

16b

X3

X100

X3

X3

TH J. direxit.

Geo. West & Sons lith et imp.

BRITISH FOSSIL PHYLLOPODA

PLATE XXX.

These specimens are all from the Lower Carboniferous Series near Eccup, Yorkshire, and are in the Museum of the Yorkshire College at Leeds.*

Fig. 1.—*Dithyrocaris insignis*, sp. nov. The inside aspect of a part of a right valve, or impress of its outside. (The uppermost of the two specimens on the slab of shale.) Nat. size. Yorkshire College Museum, Leeds. No. 33*a*. (Page 161.)

Fig. 2 *a*.—The outer aspect of an imperfect left valve. (On the same slab as fig. 1.) Nat. size. (Page 161.)

Fig. 2 *b*.—Part of the dorsal ridge of fig. 2 *a*, taken at a little above the middle. × 5. (Page 161.)

Fig. 3 *a*.—*Dithyrocaris insignis*, sp. nov. A nearly perfect carapace. Nat. size. Yorkshire Coll. Mus., No. 44 A; counterpart of No. 44 B. (Page 161.)

Fig. 3 *b*.—*Dithyrocaris insignis*, sp. nov. The posterior termination of the dorsal ridge. × 5. (Page 161.)

Fig. 3 *c*.—*Dithyrocaris insignis*, sp. nov. Part of the ornament at the anterior ventral region of the right valve. × 10. (Page 161.)

Fig. 3 *d*.—*Dithyrocaris insignis*, sp. nov. Part of the ornament of the mid-ventral region. × 50. (Page 161.)

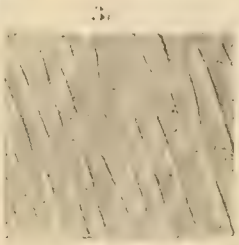
Fig. 3 *e*.—*Dithyrocaris insignis*, sp. nov. Part of the ornament of the postero-ventral region. × 10. (Page 161.)

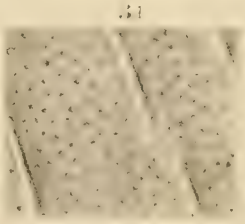
Fig. 4 *a*.—*Dithyrocaris insignis*, sp. nov. An imperfect carapace of a small individual. Nat. size. Yorkshire Coll. Mus., Leeds, No. 39 B. (Page 161.)

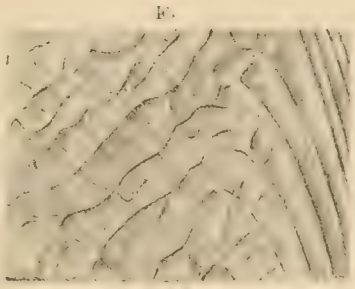
Fig. 4 *b*.—*Dithyrocaris insignis*, sp. nov. Part of the ornament of Fig. 4 *a* on the ventral region just within the marginal fringe. × 15. (Page 161.)

* The ultimate disposition of these interesting specimens from the Lower Carboniferous strata at Eccup is not yet known. Some may be deposited in the Yorkshire College at Leeds, and others in the British Museum and the Museum of Practical Geology.

Some that were collected by Prof. P. F. Kendall, F.G.S., referred to in Pl. XXV, figs. 1—5, page 159, have been presented to the British Museum (Natural History), Cromwell Road.







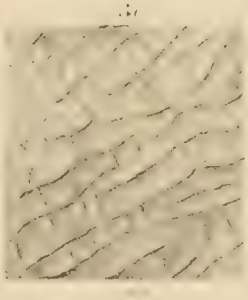


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PLATE XXXI.

Fig. 1.—*Dithyrocaris testudinea*, Scouler. Part of the ornament of Pl. XIX, fig. 8, showing pores. × 40. British Museum, I 109, No. 21. (Page 147.)

Fig. 2.—*D. testudinea*. Part of the ornament of Pl. XXI, fig. 3, showing intermediate striation. × 50. Mus. Edinb., No. 13. (Page 149.)

Fig. 3.—*D. testudinea*. Part of the ornament of Pl. XXI, fig. 6, showing pits. × 40. Mus. Edinb., No. 12. (Page 150.)

Fig. 4 *a*.—*D. testudinea*, Scouler. A part of the ultimate abdominal segment and the trifid appendage. Ventral aspect. × 2. B. M., 59541, No. 27; Pl. XXI, fig. 5.

Fig. 4 *b*.—Part of one of the stylets. × 10.

Fig. 4 *c*.—Pitted margin of one of the stylets. × 30.

Fig. 4 *d*.—Ornament of the abdominal segment. × 30.

(Page 150.)

Fig. 5.—*Chænocaris tenuistriata* (M'Coy). Left valve of a small individual, imperfect, showing the longitudinal striæ. × $3\frac{1}{2}$. Woodwardian Museum, Cambridge. Carboniferous Limestone. Settle, Yorkshire. (Page 178.)

Fig. 6.—*Dithyrocaris insignis*, sp. nov. Trifid tail-piece. Ventral aspect. Nat. size. Leeds Coll. Mus., No. 44 B. Eccup, Yorkshire. (Page 162.)

Fig. 7 *a*.—*D. insignis*, sp. nov. Ultimate abdominal plate, imperfect. Ventral aspect. × 3. Yorkshire Coll. Mus., Leeds, No. 602. Eccup, Yorkshire.

Fig. 7 *b*.—Part of the ornament of fig. 7 *a*. × 20.

(Page 162.)

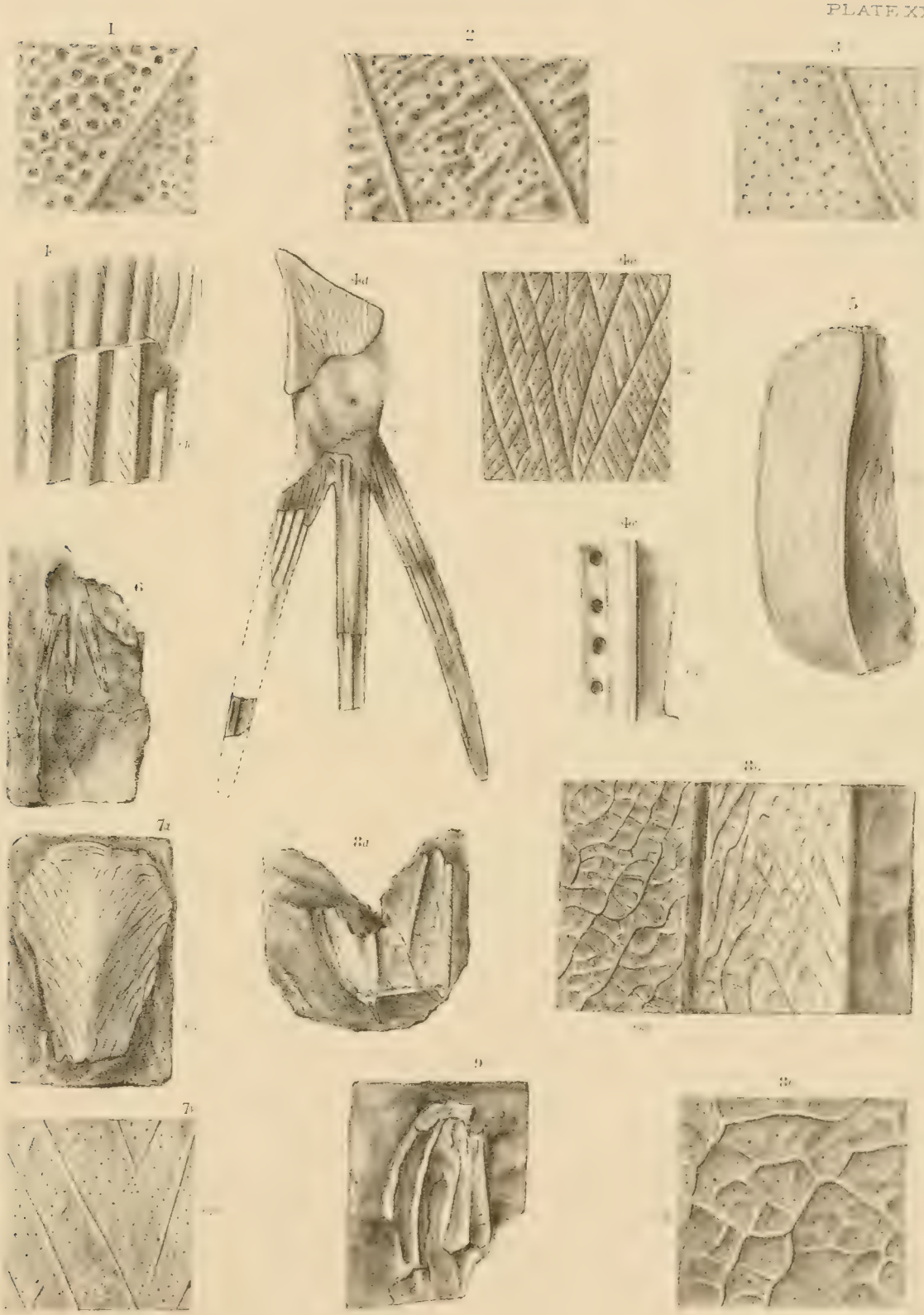
Fig. 8 *a*.—*D. insignis*, sp. nov., var. *multijugata*, nov. Posterior half of a left-hand valve. Nat. size. Yorkshire College Mus., No. 43. Eccup, Yorkshire.

Fig. 8 *b*.—Part of ornament of fig. 8 *a*. Portion of the dorsal ridge, obscured with shell on one edge. × 20.

Fig. 8 *c*.—Part of the same. × 50.

(Page 163.)

Fig. 9.—*D. insignis*, var. *multijugata*, nov. An imperfect left-hand valve, with the juxta-dorsal ridge of the adjoining valve. Nat. size. Yorkshire College Mus., No. 40. Eccup, Yorkshire. (Page 163.)



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